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Processing and Microbial Profile of "Soudamouka" a Sun-dried Fish from Sudano-Sahelian Zone of Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. Author BD and designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors DDR and BJR managed the analyses of the study. Author DDR managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Fish is an extremely perishable food item and requires preservation for future use. Several methods including drying, are used round the world for preserving fish and to extend its shelf-life. The microbial quality of sun-dried fish locally called "soudamouka" was investigated. Commercially available "soudamouka" samples were collected from retailers within the Far North region of Cameroon. Three different retailers (S1, S2 and S3) were sampled, then, the collected samples were screened for their microbial load. The highest level of *Escherichia coli* (62.10^4 cfu.g^{-1}) was recorded in S3 soudamouka sample while the lowest count (5.10^2 cfu.g^{-1}) was obtained in S1 soudamouka. The fungal load varied

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from 0, 1.10^2 to 5.10^2 cfu.g^{-1} while the *C. perfringens* load for different samples were found to be S1 = 16.10^4 cfu.g^{-1}, S2 = 20.10^4 cfu.g^{-1} and S3 = 55.10^4cfu.g^{-1}. These high microbial loads and presence of pathogens could be attributed to the poor handling practices and storage temperature by retailers. Although, drying may reduce water activity and consequently microbial load, post processing contamination may occur during post handling and transportation of processed fish to the sale points.

Keywords: Cameroon; Sudano Sahelian Zone; Soudamouka; processing; food safety.

1. INTRODUCTION

Fish is one of the most important source of animal proteins available in the tropics and has been accepted as a good source of protein. In terms of quality and nutritional values, consumption of fresh fish is preferable. Nevertheless, in tropical area fish storage is difficult due to high temperature, as fish will quickly spoil [1]. The storage problem remains very difficult because of the lack of adequate infrastructure for refrigeration. Several methods including drying, salting and smoking are used round the world for preserving fish through extending its shelf-life [2,3]. Dried fish is a very important food item used as substitute of fresh fish in many countries [4,5]. Microbial action has been known to play a large part in the spoilage of the fish [6]. Bacterial spoilage is characterized by softening of muscle tissue and production of slime and offensive odours. Bacteria such as *Salmonella*, *E. coli* and other bacteria strains have been reported to contaminate fish [7,8]. The preservation methods often incorporate drying using sun light, also other methods such as salting, smoking, cooking are used. In the case of soudamouka, only sun light is used to dry the fish after washing. According to our findings, very few studies have been conducted on the microbiological and nutritional quality of Soudamouka. Sun drying is one of the traditional methods employed to preserve fish in Cameroon. "Soudamouka" is a local type of fresh water fish of the *Moronidae* family exclusively found in Sudano- Sahelian zone of Africa [9]. This fish is very popular in the Maroua city council and its environs and it is the ethnic identity for some local tribes. Sun drying is a low-cost method and this process plays an important role in this economically disadvantage people, especially in remote areas with few rainfall and seasonal water streams. The process of sun drying of the fish consists of simply laying the whole fish on drying racks directly under sun, in the open air using solar energy to evaporate the water content in fish [10] and the dried product is called by the local population as “Soudamouka”. The quality of the fish, hygienic status and the levels of technological process employed during processing determine the level of risk of microbial contaminations aided by temperature. According to [11], temperature and humidity are important factors affecting microbial quality of fish. Its hygienic quality is not controlled and no physicochemical and microbiological analyses are performed before been released to the market, which can create doubt on its quality. The present work seeks to valorize this fish product by describing the traditional processing and assessment (assessing) of their microbial quality.

2. MATERIALS AND METHODS

To understand the manufacturing process of soudamouka sold in Maroua city council, a survey was carried out through administration of a questionnaire. People were interviewed in groups. The main points raised out were the method of processing and packaging.

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2.1 Sampling

Commercially available fish were collected aseptically from three randomly selected sale outlets: Vrick. (S1), Maroua comice (S2) and Maroua market (S3). These samples were transported in sterile polyethylene bags to the laboratory to be cultured for bacterial and fungal growth and physicochemical analysis.

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2.2 pH and Water Content

The pH of the samples was assessed using the method described by [12]. The water content was determined according to [13].

2.3 Microbiological Analysis

Microbiological analysis of “Soudamouka” was based on the research of vital microbial cells [14]. The conventional techniques of seeding decimal sample of soudamouka on specific culture media dilutions was used. 25 g of soudamouka were ground in a blender and dissolved in 225 ml of liquid dilution, Maximum Recovery Diluent (MRD). Serial dilution solutions were made for

different samples. The resulting solutions were allowed to stand for 45 minutes at room temperature to allow the microorganisms that have undergone mechanical shock to be revitalized. The decimal dilutions were performed with the solution of Maximum Recovery Diluent (MRD). Microorganisms were identified using specific growth medium.

2.4 Data Analysis

The data collected were presented as mean of the three replicates. Then the analysis of variance (ANOVA) and least significance difference (LSD student) were applied. The test was done at $P<0.05$ significance level [15].

3. RESULTS AND DISCUSSION

3.1 Processing

3.1.1 Exploratory survey

The questionnaires were administered to fishing villages namely Malawaye and Vrick as well as to whole salers and retailers in the Maroua city council.

3.1.2 Capturing fish

The fishing season of “soudamouka” is between october and november with a high productivity in November. After December soudamouka fishing is no longer possible in the area because these fish migrate to flood plains of Lake Chad via the Logone and Chari rivers. And in some areas of Logone and Chari, the soudamouka can be fished throughout the year but not in large quantities. Fishing is done mainly in the Mayo Danay (Begue, Pouss, Guirvidig, Bangwaï...) and the Logone and Chari (Zina, Reynaba, Goromo, Godini, Yvie, Ndamandi, Soumha...). The capture was done using nets with very small mesh held between two long sticks. The other form of capture is the use of fishing channels that allows the trapping of soudamouka and many other species of fish.

3.1.3 Sun drying

The drying process is very simple. As soon as the boats return from fishing, “soudamouka” are immediately recovered and optionally washed with lake water to be spread after sorting without bunk (risk of decomposition) on the racks along the shore or at home. Fishes are subjected to sun exposure and return from time to time. Sun drying takes place by exposing the product to sunlight and eliminating the water evaporated by air. If the sunlight intensity is low or sunshine duration is short, fish were spaced to allow proper ventilation. The most important thing in this process is the fact that the fishes are well ventilated. Upon drying, the decaying fish or decomposed are systematically removed from the lot. After sun-drying, “soudamouka” is packaged in bags ready for transportation (donkeys, bicycles, carts, motorcycles, rickshaws and cars) to the outlets.

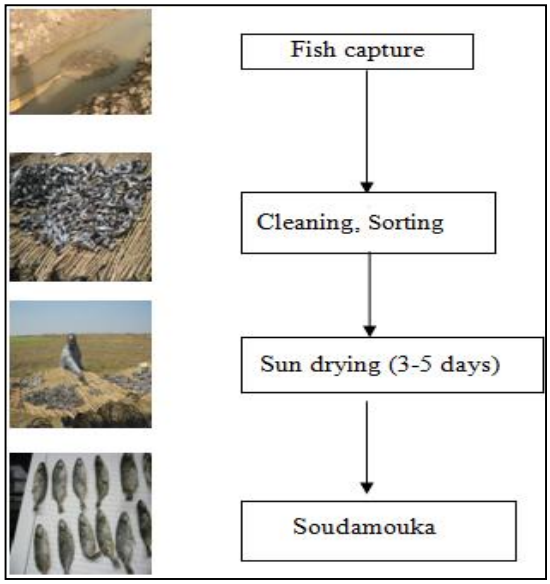

Fig. 1. Flow sheet of Soudamouka processing

3.2 Physicochemical Analysis

3.2.1 Water content

Fig. 2 shows the moisture contents of the three "soudamouka" samples. The water content of 9.75 ± 0.07; 9.70 ± 0.07% and 9.60 ±0.07 values belonging respectively soudamouka S1, S2 and S3. The analyses showed no significant differences (P>0.05) water content between different sources of soudamouka.

3.2.2 PH of soudamouka

The pH values of soudamouka were the same 5.80± 0.07, for the three samples (S1, S2 and S3). The analysis showed no significant difference (P>0.05) in pH between the three sources. The pH of soudamouka is very favourable to the development of most microorganisms. This pH is below the maximum acceptable limit of 6.0 suggested by [16] and were rather higher than those of fresh fish (pH5.98), and lower than those of dried fish products without ingredients (pH6, 39).

3.3 Microbial Load Evaluation

3.3.1 Aerobic Mesophilic Flora (AMF) of soudamouka

Fig. 3 shows the load aerobic mesophilic flora of three sources of soudamouka. The results of the AMF are: S1 = 42.10^2cfu.g^{-1} on the first day of production, which is an acceptable rate compared to the limit suggested by Pearson (1968a), which is $2.5.10^5$ to $1.6.10^8$(cfu.g^{-1}). A high load is noted S2 and S3 samples with respectively of 85.10^4 and 296.10^4cfu.g^{-1}. This suggests correcting deficiencies of packaging, transport and storage, which calls for respect for hygiene.

3.4 Fungi Flora

Fig. 4 show the load of molds and yeasts in soudamouka. The results show that the analyzed soudamouka have the following rates: S1 = 0 (cfu. g^{-1}) molds just at the end of production, S2 = 1.10^2 (cfu.g^{-1}) and S3 = 5.10^2 (cfu.g^{-1}). These results showed a significant difference (P<0.05) between different fungal flora. Only S3 had higher rate than the limit suggested by [17], which is 1.10^2 (cfu.g^{-1}). Molds and yeasts are capable of causing on one hand spoilage and can also produce highly toxic and carcinogenic products to man, the soudamouka presents serious poisoning risks to consumers. The low moisture content of soudamouka made it a product of high stability. The absence of a packaging system may promote moisture uptake and thus an acceleration of the contamination. The moisture content varied from the provenances soudamouka. It has been suggested that condition of high humidity and warm temperature predispose to high levels of aflatoxin in food often exceeding the upper limit initially established by the food and Agriculture organisation [17].

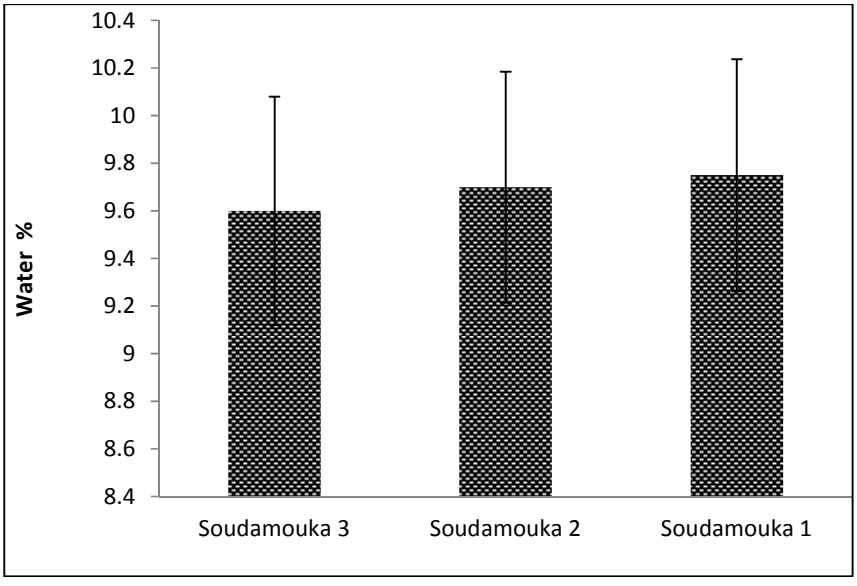

Fig. 2. Water content of Soudamouka

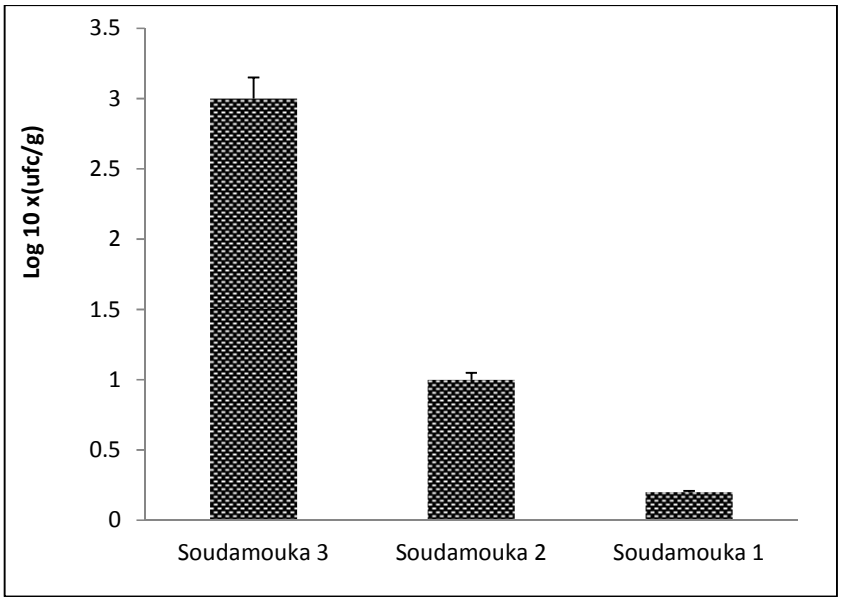

Fig. 3. Aerobic Mesophilic flora of Soudamouka

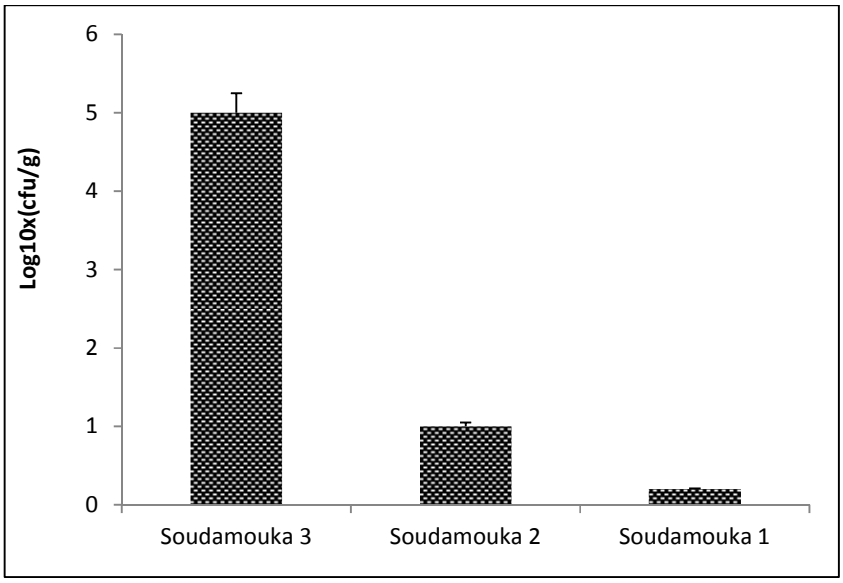

Fig. 4. Fungi flora of Soudamouka

3.5 Load of Pathogens or Spoilage Bacteria in "Soudamouka"

Table 1 showed the loads in *E. coli, C. perfringens* and *S. aureus* of "soudamouka". For *E. coli*, Analysis of the results showed a significant difference ($P<0.05$) bacterial presence between the different sources of "soudamouka". The presence of small numbers of S. aureus in food is not uncommon but not the health threats because they are eliminated by cooking or pasteurization [18]. Additionally, large numbers typically 106 cfug-1 are required for production of toxin to cause illness. Thus contamination is necessary but not alone sufficient for outbreak to occur [19]. The presence of *S. aureus* on ready-to-eat dried fish may be as a result of bad handling, cross contamination and poor temperature control [20,21]. The inherent danger associated with or without its metabolic product in various foods, without further heat treatment is the possible outbreak of serious foodborne

Table 1. Load of some pathogens isolated from "Soudamouka" samples

Samples	*Escherichia coli* (Log $_{10}$ x cfu.g^{-1})	*Clostridium perfringens* (Log $_{10}$ x cfu.g^{-1})	*Staphylococcus aureus* (Log $_{10}$ x cfu.g^{-1})
Soudamouka 1	0.1±0.0^{a}	0.01±0.0^{a}	0.12±0.0^{a}
Soudamouka 2	15±1.3^{bc}	1.8±0.0	13.6±0.2^{c}
Soudamouka 3	25±2.1^{d}	3.2±0.1^{e}	22.9±2.6^{de}

illness. We note constantly high presence of *E. coli* compared to the detection limit suggested by [17] who considered a significant flora < 10^2 (cfu. g^{-1}). This high flora *E. coli* suggests that soudamouka is produced in unhygienic conditions and makes it risky for human consumption because it is a sign of a potential presence of enteric pathogens. *E. coli* is a classic example of *enteric* bacteria causing gastroenteritis. This microorganism is used as indices of hazardous conditions during processing of fish. The contamination of food fish origin with this microorganism probably occurs during handling of fish and during production process [22]. Compared to S1, S2 and S3 have a higher flora which may indicate recontamination due to poor storage conditions. *E. coli* in ready-to-eat food like sun-dried soudamouka, including poor handling practices by food handlers [23], or cross contamination from food contact surfaces or high storage temperature as in tropics [24]. It is hardly possible to obtain products free from C. perfringens. The agents of food poisoning contain at least 1.10^{5}cfu live vegetative forms of enterotoxigenic *C. perfringens* per gram of concentration at which there is likelihood of multiplication in the small intestine of the host, sporulation and enterotoxin production. Unfortunately spores can survive during cooking, its heat labile enterotoxin. In view of the results, the soudamouka presents no risk at this level.

4. CONCLUSION

This work enabled to assess the microbial quality of "soudamouka" and its processing. It is clear that the soudamouka is sufficiently dried to minimize the risk of microbial growth and contribute to improve the stability of the product. In the standards storage and packaging of foodstuffs modes exert a protective action vis-à-vis the physicochemical and microbiological properties. The high rate of *E. coli* or spoilage bacteria showed that "soudamouka" is produced in unhygienic conditions and thus its sanitary quality is a concern and could pose a public health problem. This study also enabled us to garther knowledge on the fact that the "soudamouka" is a potentially interesting product in the market; their hygienic and technological improvements could boost consumption and even export.

CONSENT AND ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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