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Characterization of stakeholders and grilling practices of chicken meat sold in south of Benin Republic

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ABSTRACT

Chicken meat grilling is an economic activity growing in major cities of Benin. This study aimed to characterize stakeholders and grilling processes of chicken meat sold in southern Benin. Therefore, a survey was conducted at the cities of Cotonou and Abomey-Calavi in Benin, with main categories of stakeholders involved in that activity. It revealed that this sector included spice and skewer producers, frozen chicken, skewer and spice retailers, grilling processors and consumers. Commercial chicken grilling was predominantly male activity, mostly Nigerians (61%), followed by Nigeriens (31%) and Beninese (8%), in which subgroups existed. A typology of consumers showed two groups which were: adolescents, under training (22%) and adults, visitors of pubs (78%). The grilling process depended on whether it was a whole chicken or chicken pieces on skewers. The grilling devices were barrel grill (67%), charcoal cabinet, type grill (25%) and gas cabinet type grill (8%). Grilling temperature and time of whole chickens were not significantly different between the grills, except for skewers having shorter grilling time (26 min). Precooked chickens had a better yield (84%) than those grilled directly (57%), it did not vary significantly between the barrel grill and the gas cabinet type grill. These grilling parameter differences may affect the quality of grilled chicken meat.

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Keywords: Grilled chicken, materiel, process, typology, grilling processors, consumers.

INTRODUCTION

Chicken meat is one of the most commonly consumed animal-sourced foods and supplier of proteins in the world. Considered as the cheapest in the world, chicken meat consumption is increasing rapidly (Jung et al., 2011). In Benin, poultry takes the first place in conventional breeding

and chicken is the main birds raised in poultry farms, followed by turkey, duck, geese and guinea fowl (Karim et al., 2013; DE, 2016). Its consumption has increased significantly despite a slowdown due to bird flu in 2006 and 2007 (FAO, 2015). However, the insufficiency of local production to meet growing demand has necessitated the country

to import large quantities of chicken. From January to November 2018, Benin imported 87,416 tons of poultry meat only from the European Union (EC, 2019). Chicken meat is consumed, in household and out, in fried, grilled, prepared or roasted form. It can be consumed alone or with other foods. This consumption is accentuated with the growth of street food in the majority of African cities (Akintaro, 2012). Street food plays an important socioeconomic role through job creation and, income for people with low educational level and also offers affordable food for groups of low purchasing power (Lues et al., 2006; Tavonga, 2014). Among ready-to-eat meats marketed on the street, grilled chicken is an important part of the market. In Bobo-Dioulasso (Burkina-Faso), it offers a profit of about 500 FCFA per kilogram of meat sold (Montcho et al., 2018). It is usually grilled whole or in the form of chicken skewers (MRA, 2007). In Benin, grilled chicken is becoming an increasingly important part of street food, especially in the southern part of the country where chicken meat is the most consumed. Its grilling is often done with rudimentary devices and according to the knowledge of each actor. Indeed, several studies have shown the impact of meat grilling parameters on the healthy quality of the final product, particularly on their ability to promote the formation of Polycyclic Aromatic Hydrocarbons (PAHs) and heavy metals, etc. This study aimed at characterizing the stakeholders and different grilling practices of chicken meat marketed in southern Benin.

MATERIALS AND METHODS

Study area

The work was conducted in Cotonou and Abomey-Calavi, two townships located in southern Benin. Located between latitude 6°21'55" North and longitude 2°25'05" East, Cotonou is the only township in the Littoral division and is the economic capital of Benin. It houses the majority and most important formal and informal administrative and economic structures of the country. Close to Cotonou, the township of Abomey-Calavi is located between latitude 6°26'54" North and

longitude 2°21'20" East. It is located in the Atlantic division and is the most populated municipality in Benin according to the fourth General Census of Population and Housing (INSAE, 2015). Because of its demography, street food is also developed, including the sale of grilled chicken meat. These two townships were chosen because they host the majority of poultry farms and commercial establishments of poultry products, and also constitute the largest consumer market (FAO, 2015). The 6th, 10th and 12th subdivisions of Cotonou and Abomey-Calavi and Godomey subdivisions of Abomey-Calavi township (Figure 1) were selected for this study because they are the most populated of these communes and concentrate most of the economic activities; including street food (INSAE, 2015).

Sampling

Sampling consisted of identifying through a pre-survey the main groups of stakeholders in the grilled chicken value chain. The selection of individuals to be investigated was random because there was no official statistical database for this activity. Consumers were surveyed at ten (10) outlets for grilled chickens at the rate of 10 consumers per outlet. Table 1 shows the categories and number of stakeholders surveyed in the study area.

Collection of data

The pre-survey made it possible to update and validate the questionnaire intended for data collection. The stakeholders were interviewed individually using a questionnaire specific to the category to which they belong. The survey was carried out from October to December 2018 within 5 pm to 9 pm. The stakeholders surveyed were retailers of frozen chickens, grilling processors, producers and retailers of spices and skewers, and consumers. Socio-professional information such as nationality, ethnic group, sex, age, religion, marital and professional status, level of education and activities in the chain were collected. Regarding the characterization of the processes, in addition to interviews, five (5) processors per identified grilling process

were monitored during the practice of their activity and the information on the various processes and equipment used was collected, the operations units were described, the critical points that may affect the quality of the products were identified and listed. For grilling devices, the heat source-chicken distance was taken using a tape meter. Temperatures (pre-cooking and grilling) were taken every five and ten minutes respectively during skewer and whole chickens grilling using a borer thermometer (multi-thermometer ST-9269). The grilling temperature was taken at the grid top. The times of unit operations were taken using a chronometer and the grilling yield was calculated by the mass quotient of meat after and before grilling with an electronic scale (CAMRY, model EK3250, d = 1 g). Consumers were interviewed about their socioeconomic characteristics, preferences, and reasons for choice of grilled chicken meat.

Statistical analysis

Quantitative and qualitative data were recorded in Excel 2010. The descriptive statistics were performed with the Minitab 14 software. Results were expressed as mean \pm SD. Temperatures, heat source-chicken distance, grilling time and yield were compared by ANOVA one-way with the Minitab 14 software. The differences were considered significant at the 5% threshold ($p < 0.05$). The Multiple Component Analysis (MCA) was carried out using software R to evaluate the determinants of chicken grilling activity and establish the typology of grilling processors according to their socio-professional characteristics on the one hand, to evaluate the determinants of consumption of grilled chickens and establish the typology of consumers according to their socio-economic and professional characteristics on the other hand.

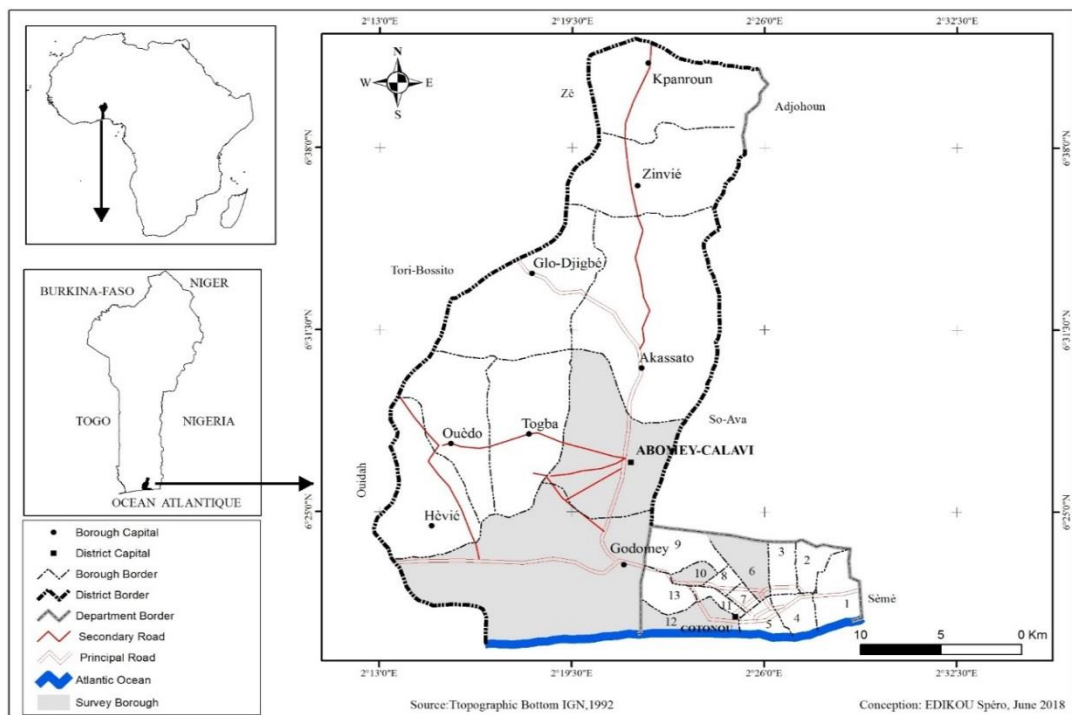


Figure 1: Map showing the study area.

Table 1 : Groups and number of stakeholders interviewed in the survey area.

Stakeholders surveyed	Survey area		
	Abomey-Calavi	Cotonou	Total
Retailers of frozen chickens	9	13	22
Spice producers	3	7	10
Skewer manufacturers	0	5	5
Retailers of spices and skewers	6	8	14
Grilling processors	50	50	100
Consumers	50	50	100
Total	118	133	251

RESULTS

Sociodemographic characteristics of chicken meat grilling stakeholders

Table 2 presents sociodemographic characteristics of stakeholders involved in chicken meat grilling.

Retailers of frozen chickens

Frozen chicken retailers supplied these products to grilling processors. They were all of foreign nationality, Hausa ethnic, Muslim and mainly constituted of Nigerians (70%) and Nigeriens (30%). They were all married and over the age of 40 and have at least 5 years of experience. They were 80% illiterate, only 14% and 6% had a primary and secondary level respectively. Grilling processors affectionately consider them as their "bosses" because of the affinity and possibility to keep their unsold grilled chicken the day before in freezer or to buy frozen chickens on credit from them. The vast majority (94%) of the surveyed retailers sold only imported frozen reformed hens chickens while the remaining 6% sold both imported frozen reformed hens and broiler chickens. These retailers source the birds from importers of frozen products.

Spice producers

Spice producers made spice formulas for chicken skewers grilling and for accompanying grilled chickens for consumption. They were all male, Muslim, ethnic Hausa, Nigerians (88%) and Nigeriens (12%), married (74%). Most of them were between 31 and 40 years old (58%), uneducated (78%) and have 5 to 10 years of experience in the profession (62%). They work closely with spice dealers for

distribution and offer different types of spice formulas (Table 3) for grilling processors. The first formula had the same composition like the second one except the red coloring. The second formula differed from the first and third ones by the red color given to it by red coloring addition whereas the specificity of the third one was the abundance of pepper powder without grilled peanut flour.

Skewer manufacturers

They made skewer from branches of *Raphia sudanica* on which were fixed pieces of chicken for grilling. They were exclusively men aged 31 to 40 years (60%), non-educated (80%) and about 80% of these manufacturers engaged in this business for at least 5 years. They were of Nigerian origin, Hausa ethnic group, and practiced Islam as a religion.

Retailers of spices and skewers

Retailers of spices and skewers are intermediaries between producers of spices, skewers and grilling processors. They were also mostly constituted of men (78%), with some women (22%). They were entirely Nigerian, Hausa, and the age is between 31 and 50 years with at least 5 years of experience. They were mostly married (80%), 91%, were illiterate and all Muslims.

Grilling processors

Grilling processors were only men. They consisted of 8% of Beninese and 92% of foreigners constituted of Nigerians (61%) and Nigeriens (31%). They were majority Muslim (92%) and 51% of them were married. 35% have primary education, 30% have not received any education, 25% have reported receiving a Koranic education, while only 10% had a secondary education. They were in

close collaboration with the other stakeholders in the chain for whom they were either customers (from whom they source raw materials) or sellers, to whom they provide grilled chickens (consumers).

Consumers

The majority of consumers were men (69%) and women (31%). They were mainly Beninese (94%) and foreigners (6%). The main ethnic groups met were Fon (45%), Goun (23%), Nago (18%), other foreigners (7% respectively). They were mostly educated, with 56% having secondary level, 33% higher and 11% without any education. Consumers were 74% Christians, 22% Muslims and 4% did not practice any religion.

Typology of chicken meat grilling processors

Figure 2 shows the correlation between the variables and principal axes of Multiple Correspondence Analysis (MCA). The first two axes realized with the (MCA) on socio-demographic characteristics and the experience of chicken grilling processors account for 49.5% of the information. The contribution and the quality of representation of the socio-demographic characteristics and the roasting activity between the two axes are high on the first axis (32.1%) for the nationality, the level of education, the types and the form of grilled chicken and the equipment used. Age, marital status, employment status, site, and number of years of experience were strongly represented on the second axis (17.4%) (Figure 3).

Figure 3 shows MCA of socio-demographic characteristics and chicken meat grilling activity. The interpretation of Figure 3 shows that the first axis (32.1%) opposed Beninese, Christians, of secondary school level, who grilled only the whole chicken using the imported broiler chicken meat and the gas grill, to foreigners of Nigerian and Nigerien origin, Muslims, with little or no education, who used imported reformed layers as a raw material, making whole chicken and chicken skewers, along with other meats. The second axis (17.4%) was between young, employed, single, inexperienced, settled in the

streets, and adults, self-employed, married, already having some experience, installed in front of bars and street intersections (Figure 3).

Thus, two groups of chicken meat grilling processors were identified:

- ✓ **Group 1 (8% of the sample):** national grilling processors: they were all Beninese, whose average age was 32.5 ± 2.8 years. They had the secondary education level, and 75% of them were married and most have experience between 5 and 10 years (62.5%). They were employed by individuals or owners of a drinking establishment and / or restaurant. They only grilled the imported broiler chicken. They used the gas cabinet type grill.
- ✓ **Group 2: (92% of the sample) foreign grilling processors:** they were mainly composed of 61% of Nigerians and 31% of Nigeriens. The average age was 36 ± 11.7 years. They all grilled chicken both whole and in the form of skewers, and also other meats such as mutton and, beef. They mainly used the meat of imported reformed layer hens as raw material. This group had three subgroups.

- **Young processors:** they were employed or in training and represented 15% of grilling processors. They were 22.33 ± 2.7 years old; and were single. Fifty percent (50%) of them had primary education and the remaining 50% were uneducated. More than 64% of these young people had an experience of 1 to 4 years. They were mostly settled around the streets (78.57%) or in front of restaurants with their employer or boss (21.43%). They used charcoal barrel grill as equipment.

- **Self-employed processors:** they represented 57% of the grilling processors and were predominantly single (56.15%) with a mean age of 33 ± 6.73 years. 42.1% of them had a primary level of education and 29.8% a Koranic study. Most of them had 5 to 10 years' experience (56.14%) in the chicken grilling business, which they mostly did in

front of restaurants (50.87%). Their grilling equipment was the barrel grill (84.21%).

- Experienced processors and employers: they represented 20% of foreign processors and were aged 53.88 ± 7.87 years; but all were married. The majority of them received no formal education, but some received Koranic education (35.29%). Most of them had more than 10 years of experience in this activity (88.23%), which they practiced in front of restaurants (57.21%) and street intersections (42.85%). They recruited 1.5 ± 0.5 employees on average and had 1.5 ± 0.5 grilling sites. The majority of them used charcoal cabinet type grill (65%), barrel grill (15%) and 20% both.

Typology of grilled chicken meat consumers

Figure 4 shows the correlation between the variables and principal axes of the CMA. The first two axes with MCA on socio-economic characteristics and consumer experience accounted for 33.8% of the information. The contribution and quality of representation of socio-economic characteristics and the consumer experience between the two axes were high on the first axis (22.7%) for age, occupation, purchasing power, preference, the motives and the consumer experience. Sex, status and frequency of consumption had a good contribution and representation quality on the second axis (11.1%).

Figure 5 shows MCA on socio-economic characteristics and consumer experience.

The first axis (22.7%) opposed young people, less experienced, in training, with low purchasing power, to adults with professional occupation and some experience of consuming grilled chicken meat, and more or less purchasing power. The second axis (11.1%) was between men, with higher purchasing power, and women, with intermediate power (Figure 5).

Thus, two groups of consumers were identified:

✓ **Adolescent consumers, under training (Group 1):** they represented 22% of

consumers and comprised mainly of pupils (95%) and apprentices (5%). Their average age was 15.4 ± 1.6 years and they were all single. This group included both boys and girls with a male dominance (60%). They all claimed they had very little purchasing power. This forced them to be satisfied with skewers (98%), because of its affordability (68.96%), followed by taste (31.03%). They had a low consumption experience of between 1 to 5 years (90%) and their frequency of consumption was once a week for the majority (80%).

✓ **Adults, visitors to drinking places (Group 2):** this group represented 78% of consumers of whom 56% were men and 22% of women with an average age of 33 ± 7.8 years. 71% of these consumers were educated, including 31% at the higher level, 33% at the secondary level and 7% at the primary level. 67% of consumers preferred whole chickens, 25% chicken skewers while 8% had no preference. 44% justified their choice for fatness, 2% for taste, and 21% for both, while the remaining 21% said they had no particular reason. Most of them had a consumption experience of grilled chickens over 5 years (69%) and they consumed twice weekly (38%) or weekly (21%).

Description of grilled chicken production

Commercial grilled chicken production included whole chicken and chicken skewers. It took place according to the steps represented in the diagram (Figure 6).

Defrosting

Defrosting involved returning the frozen chicken to a temperature that will allow it to recover its original shape to facilitate handling during operations resulting in grilled chicken. The method used varied from one operator to another. The chicken can be thawed by leaving it exposed to the ambient air for about 5 to 10 minutes, or allowing it to remain in the water for about 20 minutes. Thawing in water was a practice adopted by processors who pre-cook chicken meat.

Precooking

The grilling may be preceded by a pre-cooking of the meat. It was carried out by all

Beninese to better infiltrate the seasoning in the chicken and also reduce the cooking time of the chicken when grilling because the fuel used was gas, while it was optional for processors using charcoal grill. This was a pre-cooking in boiling water seasoned with salt, onion, spices (mixture of garlic paste, pepper, ginger, and chili) and solid flavor enhancer of trading name "Maggi Poulet". Pre-cooking was at 83 ± 5 °C for 3 to 5 minutes. At the end of pre-cooking, the meat was not only tender, but also tasty because of the seasoning.

Cutting and setting on skewer

Setting pieces of chicken meat was done using knife and involved cutting the chicken meat in order to give it the shape of a parallelepiped that fit on a skewer. The size and thickness of the slices were variable. The pieces were then skewered by the center of their length. Each skewer can be composed of 1 to 5 pieces. They were arranged from the smallest to the largest from the base of the spindle. The size and the number of pieces of meat determined the selling price. Thus, there are skewers of 100 to 500 CFA francs.

Seasoning

The seasoning depended on whether it was skewers or whole chicken. The whole unprecooked chicken was seasoned with salt and or not flavors enhancer "Maggi Poulet" which is then passed over all the meat. On the other hand, the chicken meat having been previously seasoned during the pre-cooking, was no longer subject to seasoning. Chicken skewers were seasoned with a mixture of two or three spices (Table 2) and salt powder. The skewers were well coated with the spice mixture so that they were well seasoned. The seasoning gave the grilled chicken an appetizing taste.

Grilling

Grilling consisted of cooking the chicken meat on a charcoal or gas flame. Its duration varied according to the type of grilled product. The chicken was grilled the same day of purchase. The grilling of skewers took about 30 minutes while that of whole chicken (precooked or not) lasted approximately 1 hour. Three grilling equipments were identified: the charcoal barrel grill, the charcoal and gas cabinet type grills (Figure 7).

The charcoal barrel and cabinet type grills were only used by Nigerians and Nigeriens processors carrying out this activity whereas Beninese processors exclusively used the gas cabinet type grill. The barrel grill (Figure 7a) was made with a barrel iron support, on which arranged successively a combustion recipient containing charcoal, and a grid on which the chickens were grilled. The upper part of the grill was fully open. The charcoal cabinet type grill (Figure 7b) was also formed of a parallelepiped support also made of iron, a charcoal combustion chamber, and a grid. This grill was closed at $\frac{3}{4}$ and has on its upper part an orifice. The gas cabinet type grill (Figure 7c) was composed of a parallelepiped iron support, fully closed, and divided into two parts: the grilling chamber and the fat recovery tank. It also had mounting brackets for chickens with rotational cuffs and an escape.

The barrel grill was widely used (67%) to produce grilled chicken. It was followed by the charcoal cabinet type grill (25%) and the gas cabinet type grill (8%). This clearly means that charcoal was the main fuel used for chicken grilling. The charcoals used were sourced from local markets near the grilling sites. There was not a specific type of charcoal for grilling chicken meat. The charcoal barrel and cabinet type grills had the same features except their geometrical shape that makes the difference. These two devices were different from the gas grill by the fuel used since the first two used charcoal while the latter used gas. On the other hand, processors using charcoal devices grilled imported reformed layer hens where as those using the gas device grilled imported broiler chickens. The imported reformed chicken was used mainly because of its affordable price compared to imported broilers. But processors using the imported broilers explained this choice by its good grilling efficiency and the cost of production which allowed them to generate a profit margin. All of these devices exposed chickens to fire directly during grilling, but superposing the chicken over the fire allowed the fall of oil dripping from chicken into the fire with charcoal grills. In addition, imported vegetable oil was used to coat chicken meat during grilling. This was quite the opposite in

the case of the gas grill with which the lateral arrangement of the chickens along the flame blades prevented any dripping of chicken oil into the fire. This oil was instead recovered in tank located at the bottom of the grilling device. No external oil was used during grilling. However, distance separating the chicken from the fire in the gas grill was significantly lower (9±4 cm) than that observed with the charcoal grill (23-31 cm) (p< 0.05). This distance was similar between charcoal grills.

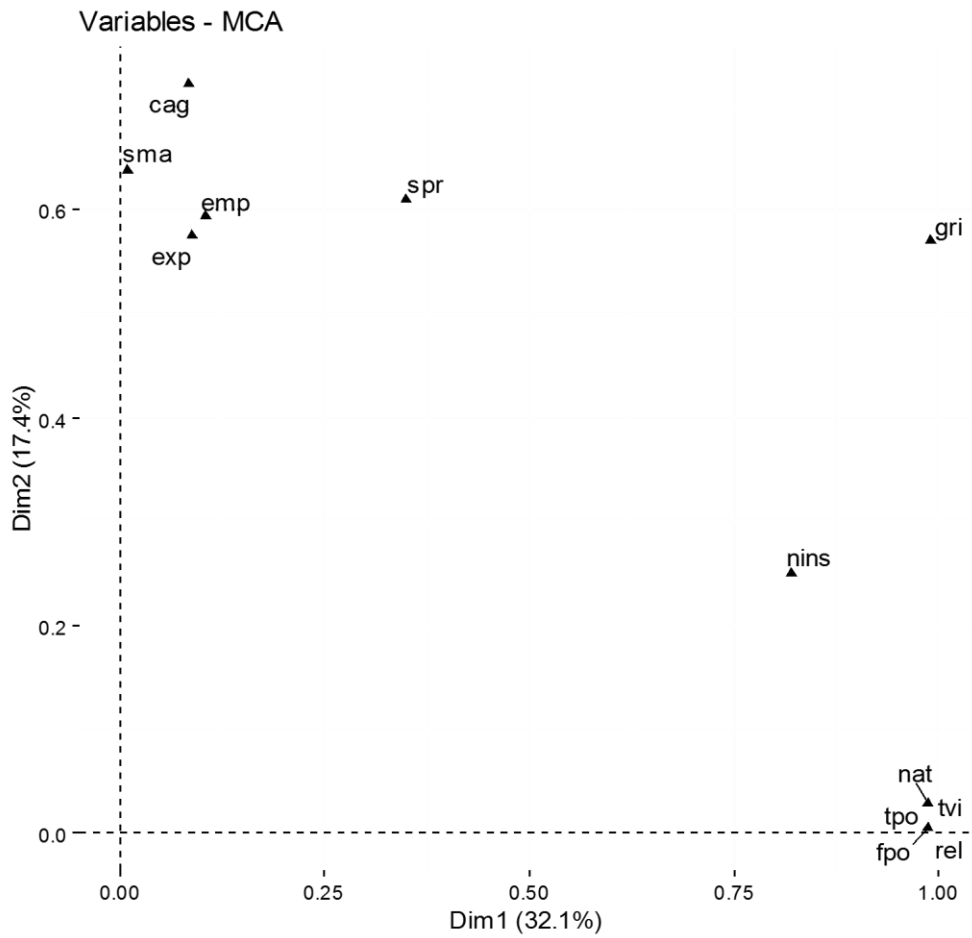
Table 4 shows technological characteristics of the grilling devices. It can be inferred that the grilling temperature and time of whole grilled chickens were not significantly different (p> 0.05) between the different grills. But, the grilling time of chicken skewers was lower than that of whole chickens. However, it did not vary significantly between the charcoal grills. The pre-cooked chickens had a better yield than those grilled directly, but this yield did not vary significantly between the barrel and the gas grills.

Table 2: Sociodemographic characteristics of stakeholders surveyed in study area.

		Stakeholders (%)					
Sociodemographic characteristic		Retailers of frozen chickens	Spice producers	Skewer manufacturers	Retailers of spices and skewers	Grilling processors	Consumers
Sex	Male	100	100	100	78	100	69
	Female	0	0	0	22	0	31
Nationality	Beninese	0	0	0	0	8	94
	foreigner	100	100	100	100	92	6
Ethnic Group	Fon	0	0	0	0	7	45
	Goun	0	0	0	0	1	23
	Nago	0	0	0	0	0	18
	Autres	0	0	0	0	0	7
	foreigner (Hausa)	100	100	100	100	92	7
	No education	80	78	80	91	30	7
Education level	Primary	14	22	20	19	35	4
	Secondary	6	0	0	0	10	56
	University level	0	0	0	0	0	33
	Coranic education	0	0	0	0	25	0
	matrimonial Status	Single	0	36	60	20	49
	Maried	100	74	40	80	51	48
Religion	Islam	100	100	100	100	92	22
	Christianity	0	0	0	0	8	74
	None	0	0	0	0	0	4

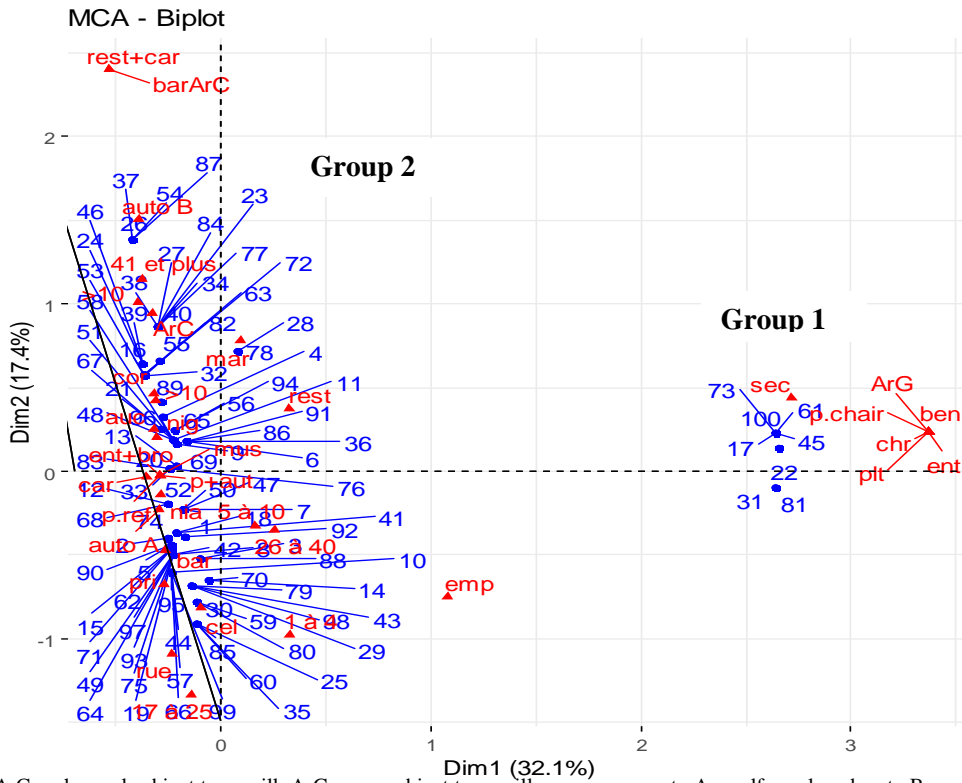
Table 3: Composition of spices for chicken meat grilling.

Formulas	Composition
Formula 1	Grilled peanut flour, chili powder, ginger powder, pepper powder, garlic powder, flavor enhancer, salt powder, curry powder
Formula 2	Grilled peanut flour, chili powder, garlic powder, ginger powder, pepper powder, flavor enhancer, salt powder, red dye or coloring
Formula 3	Chili powder, ginger powder, pepper powder, garlic powder, flavor enhancer, salt powder



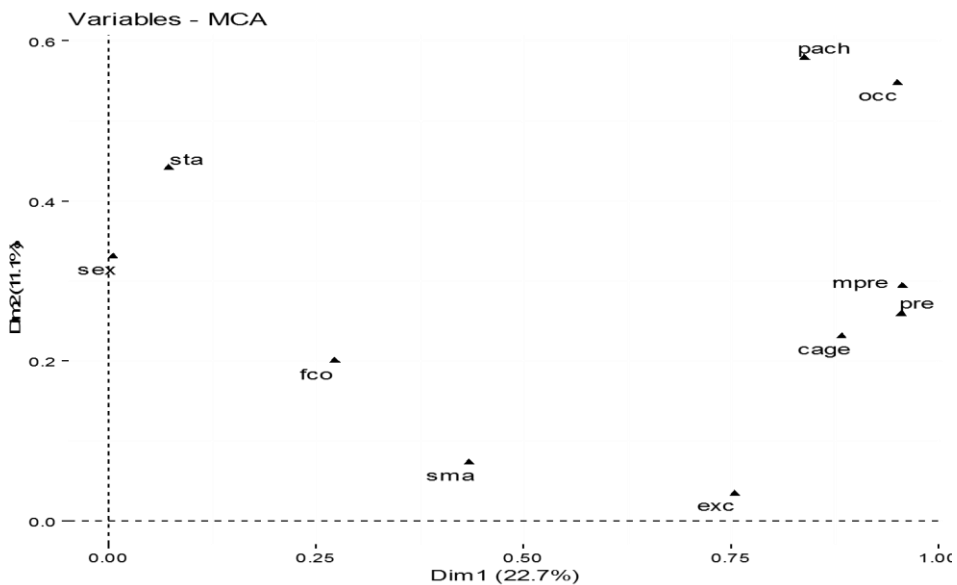
Cage = class of age, emp = site, exp = years of experience, fpo = form of chicken meat, gri = equipment, nat = nationality, nins = education level, rel = religion, sma = marital status, spr = employment status, tpo = type of chicken meat tvi = type of meat.

Figure 2: Correlation between the variables and principal axes of the MCA.



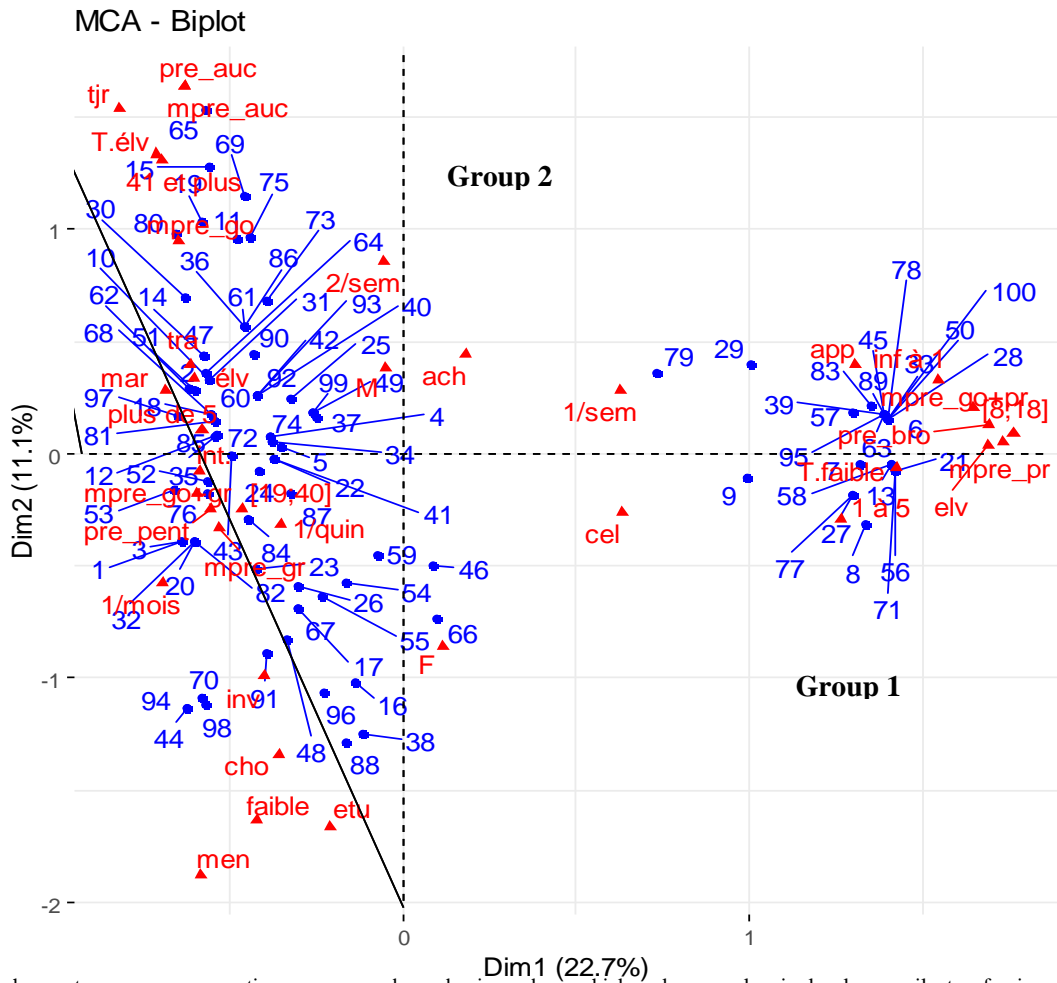
ArC = charcoal cabinet type grill, ArG = gas cabinet type grill, auc = none, auto A = self-employed, auto B = employer, bar = barrel grill, ben = beninese, car = crossroad, cel = single, chr = christian, cor = coranic, emp = employed, ent = whole, ent+bro = whole chicken and chicken skewer, mar = married, mus = muslim, nia = nigerian, nig = nigeriren, plt = chicken, p+aut = chicken + others, p.ref = reformed chicken, p.chair = broiler chicken, pri = primary, rest = restaurant, sec = secondary.

Figure 3: MCA of socio-demographic characteristics and chicken roasting activity.



Cage = class of age, exc = consumption experience, fco = consumption frequency, mpre = raisons of preference, occ = occupation, pach = purchasing power, pre = preference, sex = sex, sma = marital status, sta = consumer status.

Figure 4: Correlation between the variables and the principal axes of the CMA.



ach = customer, app = apprentice, auc = none, ben = beninese, bro = chicken skewer, cel = single, elv = pupil, etr = foreigner, etu = student, F = female, go = taste, gr = fatness, inv = invited, M = male, Mar = married, men = housewife, pent = whole chicken, pr = price, tra = professionally occupied, 1/sem = 1time per week, 2/sem = 2 times per week, 1/quin = 1 time per about fifteen.

Figure 5: MCA of socio-economic characteristics and experience of chicken meat consumers.

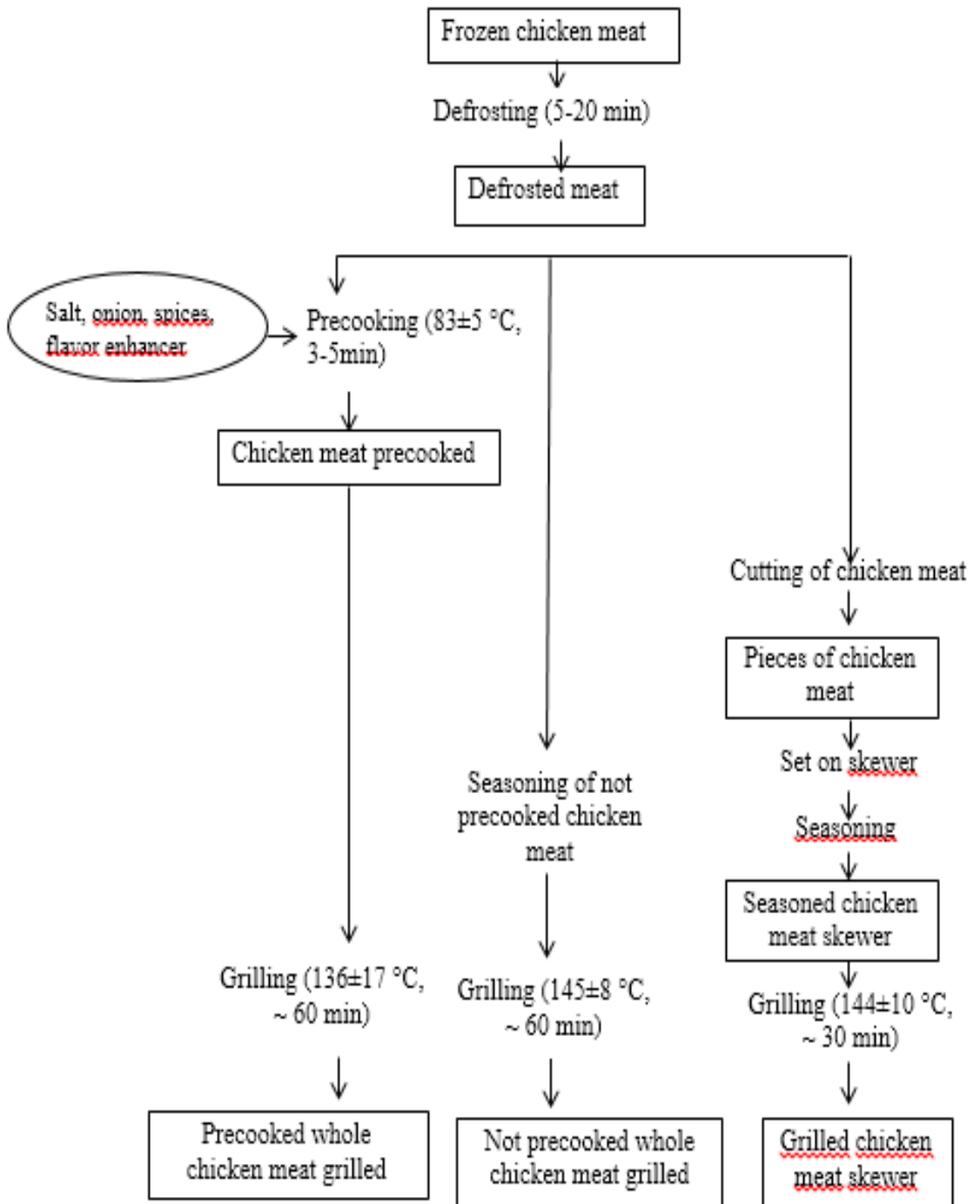


Figure 6: Diagram of grilled chicken meat production.

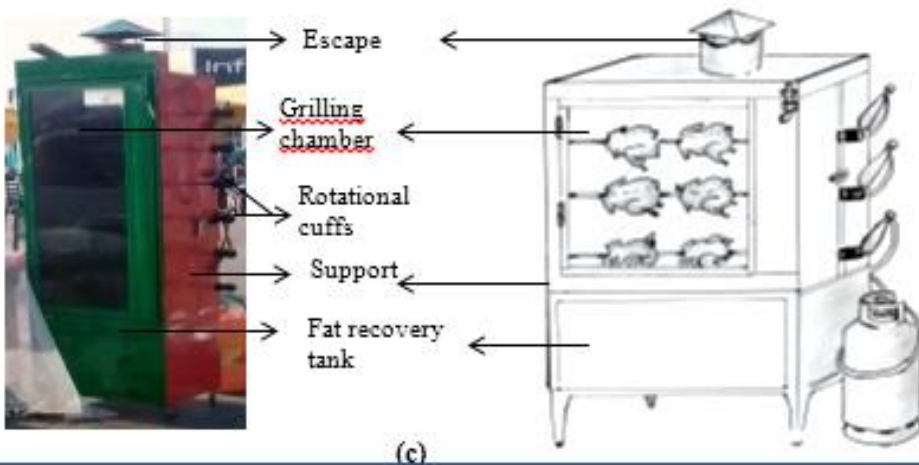
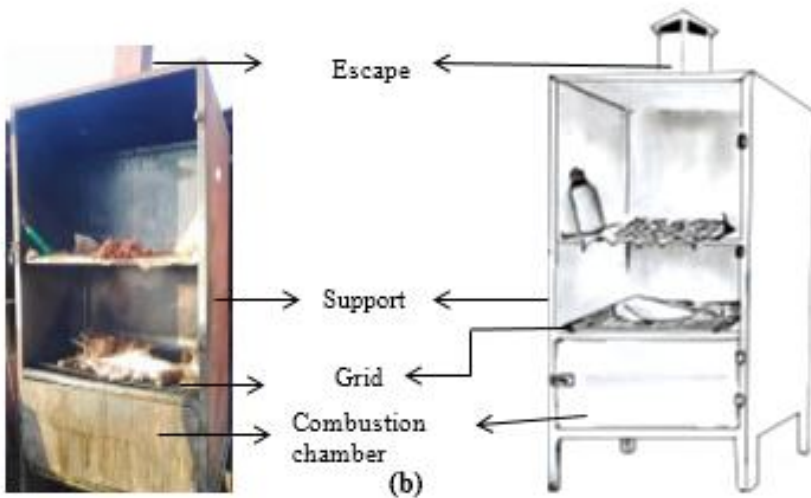
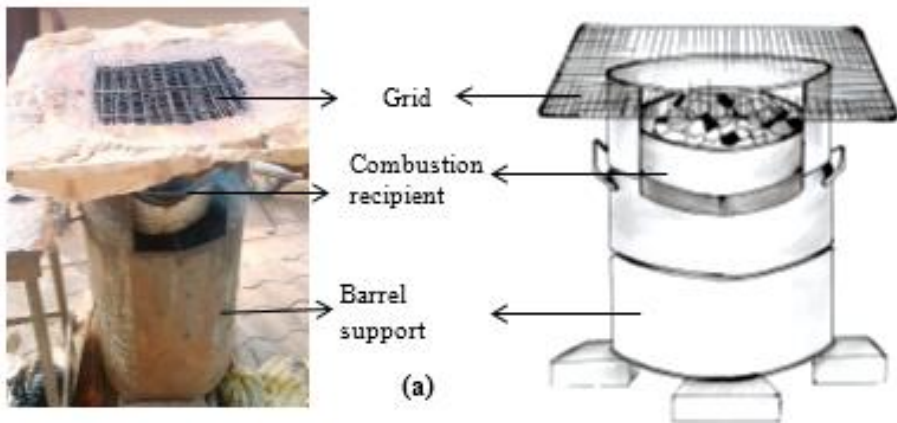


Figure 7: Equipment used for commercial chicken grilling: Barrel grill (a), charcoal cabinet type grill (b) and Gas cabinet type grill (c).

Table 4: Technological characteristics of chicken grills.

Grilled chicken	Type of device	Grilling Temperature (°C)	Grilling time (min)	Grilling yield (%)
Whole chicken	Barrel	145±8 ^a	64±7 ^a	57,5±6,5 ^b
	Charcoal cabinet type	132±17 ^a	55±8 ^a	63,5±4,8 ^b
Whole chicken pre-cooked	Gas cabinet type	134±11 ^a	59±18 ^a	84±14 ^a
	Barrel	136±17 ^a	61±4 ^a	84,7±5 ^a
Chicken skewer	Barrel	144±10 ^a	26±8 ^b	75±1,41 ^a
	Gas cabinet type	133±20 ^a	19±5 ^b	82,9±1,2 ^a

Values with different letters in the same columns are significantly different at $p < 0.05$.

DISCUSSION

Our study showed that the chicken grilling activity was exclusively for men. The grilling processors were predominantly Hausa, non-educated, and Muslim. These results are in agreement with those of Montcho et al. (2018) who found that the sellers of grilled meat in Bobo-Dioulasso (Burkina-Faso) were entirely men, mostly of Hausa ethnic group (62%), uneducated (74%) and Muslims (81%). But, they contrast with those of Muyanja et al. (2011) who reported that women were predominant in the trade of all street foods in Uganda. Kpoclou et al. (2013) and Assogba et al. (2019) also showed respectively, that shrimp and fish smoking activities were exclusively practiced by women in Benin. The Hausa ethnic vendors found in this study were of foreign nationality (Nigerian and Nigerien), unlike those found by Moncho et al. (2018) who were nationals (Burkinabe). Also, our study has shown that grilled chicken grilling was very little practiced by Beninese (8%). Indeed, according to Karli (2007), the meat trade takes into account socio-economic, ethnic, religious and traditional considerations. Montcho et al. (2018) categorized meat grilling processors into four groups: young beginners, mutton and beef meat grilling processors, owners of several grilled meat sites, and full-service professionals who grilled beef, mutton and chicken.

In the present study, it was found that the majority of consumers were men from various socio-professional groups. Montcho et al. (2018) also found that the majority of consumers of grilled meat (including grilled chicken) were men, coming from several socio-professional groups. This study revealed that grilled chickens sold to consumers were exclusively imported chickens (reformed chicken and broiler). Although in Benin, Karim et al. (2013) showed that the local chicken called "bicycle chicken" was preferred by consumers, to modern breeds, and frozen ones that were imported. Indeed, consumers preferred local chicken for the consistency of its meat that can stay for a long time on fire without disintegrating and because of its low fat therefore better for health (Sodjinou et al., 2015). In addition, Kyarisiima et al. (2011) reported that consumers in Kampala (Uganda) preferred local chicken meat because of the taste and absence of chemical contaminants. In South Africa, however, Dyubele et al. (2010) found that consumers preferred imported broilers to local chickens, and grilled chickens to those boiled for sensory reasons. Depending on the frequency of consumption, the fidelity and the quality of the grilled meat, Montcho et al. (2018) identified three groups of consumers: young and single consumers, married consumers, and the friends and relatives of grilled meat sellers.

It was found in this study that mainly two types of fuel were used to grill chicken. These were charcoal (mostly) and commercial gas. In developing countries, charcoal remains a widely used fuel in food cooking. In contrast, in developed countries, the use of gas and electricity are in people's daily lives for the preparation of food and is becoming more and more important in the grilling of meat. In fact, gas is more advantageous than charcoal in terms of energy efficiency, the health quality of the food (formation of carbonaceous substances) and the environment. However, their high cost and availability limit their use in developing countries, particularly in sub-Saharan Africa, unlike charcoal which is available and affordable (IEA, 2002; Ellegard et al., 2003; Bailis, 2005; Johnson, 2009). In addition, it was shown that the type of fuel used affects the formation of HAPs during meat grilling (El Badry et al., 2010; Viegas et al., 2012). The chicken grilling devices found in this study were the barrel and cabinet type grill. The grilling equipment can affect the quality of the grilled chicken. Recently, Adomeh (2018) showed that grilled chicken meat with the semi-spherical drum kiln was of better quality (low water content, high protein content, fiber and ether extract) compared to other types of grills used namely, the perforated clay pot, drum with upper lid cutoff cover and drum with both lids sealed. Moreover, Tougan et al. (2013) showed the existence of relationships between the technological and nutritional quality of chicken meat according to the ecotype in Benin. Our study revealed three devices for grilling chicken meat. But for the smoking of the fish for example, there is a panoply of devices, going from the most rudimentary to the improved ones. We can cite the longitudinal, rectangular and, circular traditional smokers; improved furnaces named *parpaing*, *chorkor*, *altona*, etc. (Ekomy, 2005; Ndiaye et al., 2009). Ekomy et al. (2013) designed and manufactured two improved smokers: one made of clay bricks with two smoking chambers and the other with a chamber with wooden walls. According to

these authors, these smoking chambers have halved the consumption of fuel (wood) and about 4/5 the smoking time compared to traditional smoking chambers. On the health side, the formation of polycyclic aromatic hydrocarbons (PAHs) has been considerably reduced in smoked fish with these improved smokers. Like smoking, grilling is one of the main cooking methods responsible for the formation of PAHs in foods. Indeed, during grilling, direct submission of the meat to a high temperature under a flame or embers leads to the drop of fat on fire which causes the formation of PAHs as numerous as the temperature is high (Agerstad et al., 2005; Akpambang et al., 2009; Viegas et al., 2012).

Our study showed that with charcoal grills used, the contact between the chicken meat and the embers was direct with a vertical disposition, thus causing the drop of the oil dripping from the meat on the fiery embers. This oil drop can generate fumes containing volatile PAHs that adhere to the surface of the food (Alomirah et al., 2011). With the gas grill in the contrary, although the contact was also direct between the flame blades and the chicken, the lateral disposition of the meat with respect to the flame did not allow the fall of the oil dripping from the meat on it as in the case of the first charcoal devices. However, with the gas grill, the grilling flame was closer to the meat than with charcoal grills. Factors promoting the formation of PAHs in meat include meat fat content, method and duration of cooking, fuel type, proximity and direct contact with the heat source (Farhadian et al., 2012; Purcaro et al., 2013). Therefore, the equipments met in this study for chicken meat grilling are susceptible to promote PAHs formation in the grilled chicken meat.

Conclusion

It has been shown in this study that grilling chicken meat marketed at Cotonou and Abomey-Calavi was an activity carried out exclusively by men, mainly of Nigerian and Nigerian nationalities, Hausa ethnic group and few Beninese. Also, two types of consumers namely: adolescents, preferring

chicken skewers; and adults, visitors of drinking establishments preferring whole chickens. In addition, grilling processes varied between whole chickens meat and chicken skewers grilled. The chicken meat grills used were the charcoal barrel and cabinet type grills and gas cabinet type grill. Technologically, the grilling time and temperature were similar for all three devices except yield. The yield obtained with the gas grill was higher than the other two. In addition, the barrel and charcoal grilling devices led to the drop of fat dripping meat in the embers, unlike the gas grilling device. Given the socio-economic importance of this activity which provides vital resources to stakeholders and contributes to the individual and / or collective street food, particular attention should be given to its products (grilled chicken) regarding quality on all aspects. Hence, further studies should be carried out in order to assess the safety of these grilled chicken meats for the well-being of consumers.

COMPETING INTERESTS

Authors declare no competing interests for this paper

AUTHORS' CONTRIBUTIONS

KUSE conceived questionnaires, collected and analyzed data and, wrote the manuscript. AJD, GEO, and JD corrected the questionnaires, supervised the work, and corrected the manuscript. EOO corrected and contributed to the improvement of the manuscript.

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