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Research Article

Implementation of *kilishi*'s Construction Quality by the Savannahs Northern Cameroon Production Actors

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Abstract

Kilishi, a snack food made from strips of meat seasoned with a cocktail of ingredients, dried and/or grilled, represents one of the traditional forms of meat preservation practiced in the savannah areas of Africa. This food, highly prized for its organoleptic qualities, has high commercial potential, estimated at approximately 8 billion CFA francs in Cameroon and 40 billion CFA francs in the Lake Chad region if technological improvements are made. While several scientific studies have focused on the drying, health, and nutritional quality of *kilishi*, the construction of product quality by production actors has not generated much scientific interest. This study was initiated with the aim of highlighting the approach taken by 30 production actors to construct the quality of *kilishi*. The analysis of the technical practice highlights an exclusively male activity, carried out globally at over 80% by the Hausa. The involvement of actors in the *kilishi*'s production activity is mainly driven by its family character, secondarily associated with the market potential. Based on the main descriptor of meat, tenderness, the stakeholders of the *kilishi* technical system preferentially choose 06 muscles (Eye round, Topside, Walnut cottage, Knuckle, Rib eye, Scoter). Unwinding constitutes the essential component of know-how in the production of *kilishi* and is the major constraint of the process, followed by the technological quality of the meat. The actors implement quality indicators throughout the *kilishi* manufacturing process (technological quality of the meat, low susceptibility to rancidity, thinness of the strips, low density of holes, texture of the strips, color of the strips, compliance with the dosage of spices, softening of the dry strips, characteristic color, flavor, friability of the *kilishi*). All of this reflects their approach to developing the final quality of *kilishi*, characterized by its flavor, texture (tenderness, friability, spice adherence, low hole density), and shelf life.

Keywords

kilishi, Constraints, Quality Management, Production Actors

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1. Introduction

Kilishi, strips of dried meat, is a representative component of the food and cultural heritage of the populations of the African savannahs, with an estimated market potential of approximately 8 billion CFA Francs in Cameroon and 40 billion CFA Francs in the Lake Chad region [1]. The preservation function, coupled with the commercial potential of *kilishi*, justifies the interest in its promotion through the development of its production system and product quality assurance. Various research studies conducted on the *kilishi* production system highlight production constraints inherent to the marketability of the final product [2-6]. The lifting of these constraints conditions the development of the market potential of this product, through a better understanding of the technical production system by the actors, integrating the identification of constraints associated with technical practices, the evaluation of the perception of product quality and management methods, in relation to the identified constraints, with a view to identifying ways of improvement. Therefore, the objective of this study focuses on the analysis of the construction of *kilishi*'s quality by the production actors of the northern savannahs of Cameroon, based on the hypothesis that the territorial diversity of technical practices carries a variability of the notion of quality by the actors.

2. Materials and Methods

2.1. Diagnosis of the Quality Construction and Constraint Management

2.1.1. Study Area

The study was conducted in the three main urban centers of the savannah regions of Northern Cameroon (Ngaoundere, Garoua, Maroua) due to their position as leading capitals of cattle breeding in Cameroon and a showcase for artisanal meat processing. The study was conducted as a survey based on a free conversation with production workshop managers and *kilishi* consumers in the three urban centers.

2.1.2. Selection of Respondents

10 workshops in each city were selected based on their reputation in the local kilishi production system and their willingness to participate in the study. Workshop managers and 25 consumers purchasing *kilishi* from these workshops served as interview targets.

2.1.3. Conducting Investigations

(i). Survey Structure

The surveys were conducted from a guide whose components were as follows:

i) Three areas of interest for workshop managers:

a. Detailed description of unit operations in the production processes;
b. Identification of constraints and determinants of the production quality;
c. Quality management by actors.

ii) Two areas of interest for consumers:

a. *Kilishi* appreciation attributes;
b. Barriers to purchase;

(ii). Survey Implementation

The surveys were conducted using a guided conversational approach, the interviewer taking notes using the guide. The conversations were conducted individually. Consumers purchasing *kilishi* in the production areas were also interviewed using the same protocol. The discussions in each workshop lasted an average of 2 hours 30 minutes, including conversation, observation of practices, and discussion with consumers.

2.2. Survey Data Analysis

The collected data were coded into modalities and analyzed in terms of frequency of occurrence of the modalities using Sphinx Plus V.5 Software.

3. Results and Discussion

3.1. Actors in *kilishi* Production

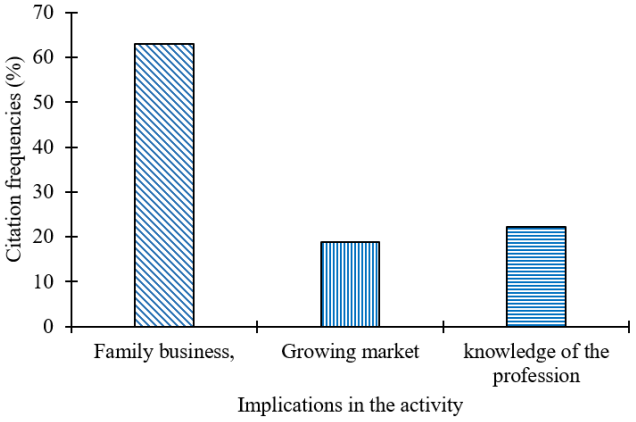

Figure 1. *Reasons for the involvement of actors in the activity.*

Kilishi production in the savannah regions of Northern Cameroon is an exclusively male and ethnic activity, carried out more than 80% by the Hausa, who are mainly herders, traders, and migrants. This result corroborates those of [2-4]. For these populations, the processing of meat into *kilishi* is originally a form of preservation of the product, which can thus be easily consumed during migrations, which is also reported

by [2, 7]. Thus, the Hausa, custodians of the secular know-how of the *kilishi* system, associate it with their traditional activities of trade, soybean production (roasted meat), sheep farming and butchery. The involvement of actors in the *kilishi* production activity is mainly driven by its family nature, followed by the knowledge of the profession, the market potential came at the third position (Figure 1). Thus, the acquisition of know-how is based on a technical transfer from father to son, the learning resulting from the fact that the actor grew up and lived in the environment of *kilishi* production.

3.2. Quality Construction and Constraint Management

3.2.1. Muscle Selection

For production actors, the quality of *kilishi* is built throughout the implementation of the process, which involves the selection of quality beef. According to them, the choice of meat for *kilishi* production is based on: its tenderness (a major criterion), its freshness, its color, and its low fat content. These criteria justify the preferential choice of muscles from the rear of the carcass (Walnut cottage, Topside, Eye round) or the scoter and knuckle from the forequarter when premium meat is scarce (Figure 2). If operators generally have a preference for hindquarter muscles, it is because they combine tenderness with the hindquarter, which seems to justify this preeminence of hindquarter muscles, which are so low in collagen and therefore highly tender. Indeed, a high collagen content negatively affects meat tenderness and is responsible for basic toughness [8-11]. Based on the main meat descriptor, tenderness, actors in the *kilishi* technical system preferentially chose six muscles (Rib eye, Eye round, Walnut cottage, Topside, Knuckle, Scoter) (Figure 2). This choice by actors corroborates the results of [2, 4, 5], for whom the muscles primarily used in *kilishi* production come from the rear globe and shoulder. Tenderness appears to be the predominant criterion, as it is defined as the most important sensory descriptor by [8-11].

Actors in the concern to manage the forecast constraints of manufacturing and preservation integrate other parameters in the choice of meat, such as freshness, the color of the meat which plays a decisive role at the time of purchase, because it is instinctively linked to the freshness of the product, and lean meat. It should be noted that the conditions of slaughter are a critical factor in the construction of this quality, insofar as, if they are not controlled, they can be a source of stress for the animals with unfavorable consequences on the quality of the meat. This stress can be the origin of meat with high pH, called Dry-Firm-Dark (DFD), dark color, firm texture and also conducive to the development of microorganisms, therefore to deterioration [10, 12].

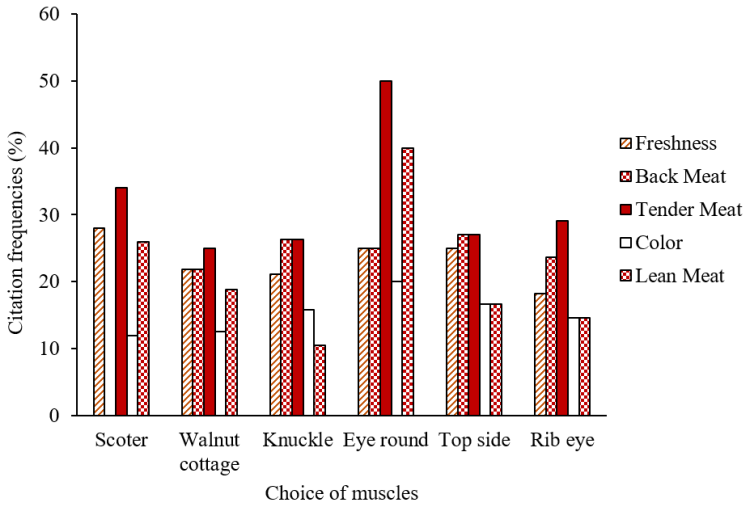

Figure 2. *Muscles preferentially used in kilishi production.*

3.2.2. Process Choice

While generally and in all areas, the meat strips from unwinding are dried in the sun for 7 to 10 hours during the dry season (90%), some specific actors, particularly in Ngaoundere, attached to the centuries-old tradition of *kilishi* production, prefer drying and smoking over a low fire for an entire night, followed the next day by drying for 3 to 4 hours in the sun to eliminate smoke odors. It is the type of drying that differentiates the *kilishi* manufacturing processes (Figure 3) as reported by [2, 13].

3.2.3. The *kilishi* Manufacturing Process and Quality Management

Trimming, unwinding the meat, drying, coating, and grilling are the basic operations involved in *kilishi* manufacturing, although there are variations depending on the area and/or ethnic group (Figure 4). This manufacturing process is com-

parable to the processes described by [2, 3, 13]. This would be due to the fact that the involvement in the *kilishi*'s production activity is mainly driven by its family character, which means similar process, as far as more than 80% actors are Hausa.

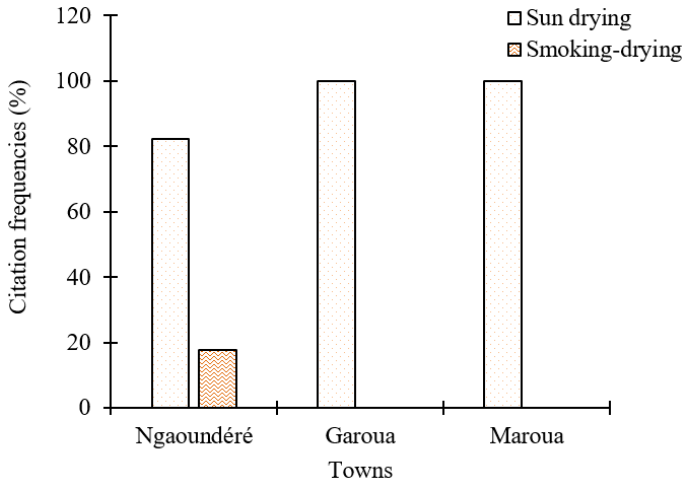

Figure 3. *Differentiation of processes according to the type of drying.*

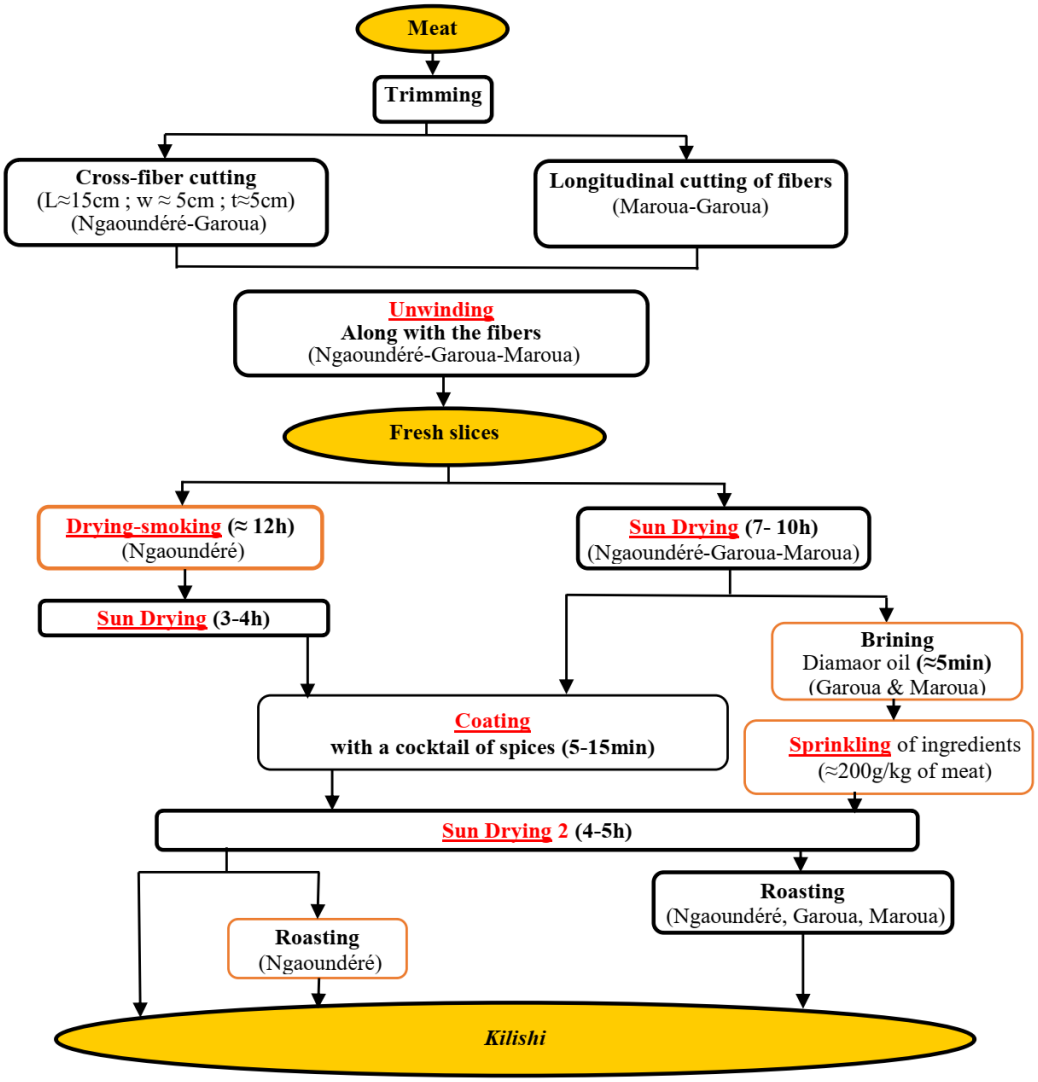

Figure 4. *Kilishi production flowchart in Northern Cameroon.*

At the level of each unit operation and with a view to build *kilishi* quality, production actors have established key performance indicators, which are outlined below.

3.2.4. Unwinding

Meat from slaughterhouses or butcher shops is trimmed by removing the aponeuroses and fatty tissues, then cut using two approaches depending on the production areas to prepare for the unwinding operation: i) Crosswise cutting relative to the muscle fibers to obtain parallelepiped slices (L ≈ 15 cm; w ≈ 5 cm; t ≈ 5 cm), practiced by actors in the cities of Ngaoundéré and Garoua. ii) Longitudinal cutting parallel to the muscle fibers, resulting in spindle-shaped pieces, practiced in the cities of Maroua and Garoua. The unwinding operation consists of cutting the piece of meat into a thin, continuous strip using a thin, sharp knife, on all sides of the piece, including the edges. This is referred to as external rotary unwinding (ERU). The result is the transformation of the prepared piece of meat into a single, thin strip (1 to 3 mm thick) as wide as possible. Unwinding is a delicate operation, requiring proven skill and dexterity. To manage this constraint, production unit managers call upon the most experienced members of the workshop or skilled workers paid for the job. In this respect, Unwinding constitutes the essential component of know-how in *kilishi* production. Performing it manually, with a thin, sharp knife, carries a high risk of injury, as can be seen from the multiple scarifications on the hands of the operator (Figure 5). The precision required by the operation and the risks involved make unwinding the most restrictive component of the *kilishi* manufacturing process, as reported by [2, 3, 13].

Figure 5. *Finger scars resulting from unwinding the meat.*

The central requirement of the unwinding operation relates to key performance indicators to assess the quality of the operation. It concerns the fineness of the thickness of the strip obtained, the density of holes, the length and the transparency of the strips (Figure 6). These requirements justify the know-how and precision required of the operator, and will facilitate, if necessary, the subsequent drying operation in terms of speed, with a potential impact on the friability of the *kilishi*. It goes without saying that the success of the unwinding depends, beyond the know-how of the operator, on the technological quality of the meat, in this case its tenderness as reported by [4, 5].

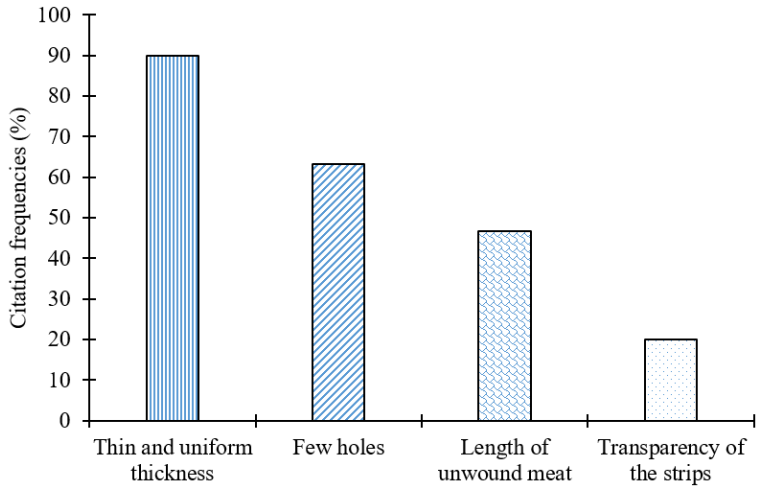

Figure 6. *Quality criteria for good unwinding.*

3.2.5. Drying of Unwound Strips

While unwound strips of meat are generally dried in the sun in all areas, some operators, particularly in Ngaoundéré, who adhere to the centuries-old tradition of *kilishi* production, prefer drying and smoking over a low flame (see Figure 3). Indeed, while the process can be completed in 7 to 10 hours during the dry season, it can take much longer during the rainy season. To this end, operators are often forced to use a fan or resort to drying and smoking to speed up the drying process. To evaluate this individual process and manage constraints, operators use indicators. These indicators include the rigidity

of the strip, which contributes to the subsequent brittleness of the *kilishi*, the most important descriptor of the drying quality indicators. It should be noted that this rigidity does not mean absolute rigidity, because the dried lamella must be malleable, which is why the actors associate the desired rigidity with the softness of the lamella, although the latter characteristic is cited infrequently. In the same vein, the actors associate the quality of drying with the change in color of the lamella, which goes from bright red, which is that of the oxygenated pigment (oxymyoglobin), to brown, which is that of the oxidized myoglobin (metmyoglobin) as reported by [14], with the reduction in the weight of the lamellae, with the solidification of the fats and the softness of the lamellae (Figure 7).

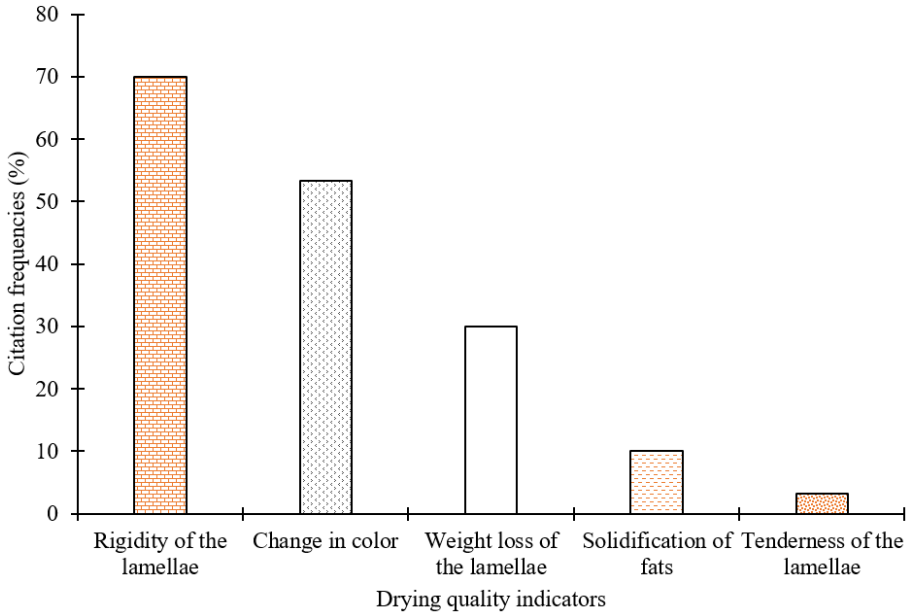

Figure 7. *Quality criteria for drying unwound lamellae.*

3.2.6. Coating the Dried Strips

The dried meat strips are coated in a cocktail of spices integrated into a matrix made of runny peanut paste (Table 1). A wide range of spices is used, likely depending on their local availability, with a greater use in terms of spice types and quantities in the city of Ngaoundere as reported also by [13]. This could explain the reputation of *kilishis* from this geographical area for having a more intense flavor than those from the cities of Maroua and Garoua, where producers appear to have similar formulations with little differentiation between spices.

Table 1. *Average composition of the kilishi spice cocktail (g/kg of spices) used by the actors.*

Ingredients		**Production sites**		
Scientific names	**English names**	**Garoua**	**Maroua**	**Ngaoundere**
Zingibe officinale	Ginger	16,08 ±0,59[a]	89,6 ±1,56[b]	94,41 ±5,54[b]
Piper guineense	White Pepper	13,5 ±0,71[a]	2,15 ±1,2[b]	1,76 ±0,62[b]
Eugenia caryophylata	Cloves Chili	3,93 ±0,37[a]	1,91 ±0,83[b]	1,41 ±0,12[b]
Capsicum frutescens	Pepper	25,41 ±0,12[a]	28,33 ±0,94[b]	28,83 ±1,65[b]
Monodora myristica	Nutmeg	2,83 ±0,23[a]	11,6 ±0,85[b]	14,41 ±1,29[c]
Allium sativum	Garlic	8,21 ±0,16[a]	12,85 ±0,49[b]	14,25 ±1,06[b]
Hua gabonii			6,58 ±0,12[a]	6,43 ±0,33[a]

Ingredients		Production sites		
Scientific names	**English names**	**Garoua**	**Maroua**	**Ngaoundere**
Xylopia aethiopica	Kimba (Hausa's name)		4,25 ±0,35[a]	5,91 ±0,59[b]
Chlorure de sodium (NaCl)	Salt	11,75 ±2,47[a]	14,75 ±0,35[b]	15,75 ±1,06[b]
Allium cepa	Onion		130,9 ±0,85[a]	151 ±1,41[b]
	Curry			2,71 ±0,54
	Maggi Cube	11,5 ±2,12[a]	12,25 ±1,06[a]	11,85 ±0,92[a]
Pimpinella anisum	Anise			1,33 ±0,47
$C_6H_{12}O_6$	Sugar		16 ±1,41[a]	15,75 ±1,06[a]
Thymus alpestris,	Thyme			3,015 ±0,45
Ocimum basilicum	Basil			22,75 ±1,06
Petroselinum crispum	Parsley			7,915 ±0,59
Apium graveolens	Celery			15,25 ±0,35
Capsicum annuum	Green Pepper			16,75 ±1,06
Acetic acid	Vinegar			16,175 ±0,7
Bixa orellana	Coloring	1,4 ±0,28[a]	1,1 ±0,14[a]	
	Oil	27 ±1,41		
Arachis hypogea (paste)	Peanut			642,5 ±10,61
Arachis hypogea (Peanut cake)	Peanut cake	1810 ±14,14[a]	2155 ±7,07[b]	
(H_2O)	Water	982,5 ±3,54[a]	1012,5 ±17,68[a]	797,5 ±3,54[b]

N.B: Values with the same letters do not differ significantly at the probability threshold ($p<0.05$).

The formulation of the spice cocktail can also vary from one ethnic group to another and seems to be associated with the dietary habits of the production operators. The major spices used are: ginger (*Zingiber officinale*), onion (*Allium cepa*), clove (*Eugenia caryophylata*), white pepper (*Piper guinense*), to which chili pepper (*Capsicum frutescens*) can be associated, the use of which makes it possible to differentiate spicy *kilishi* from non-spicy *kilishi*. Various minor spices are included in the cocktail, such as *Bixa orellana*, a red-colored plant used by the Hausa in the towns of Maroua and Garoua to differentiate spicy *kilishi*, as well as various aromatic barks and seeds called in hausa passakori and koullah. The formulated spices are used in two ways, coating and sprinkling (Figure 8). Coating consists of dipping the dried strips in a matrix made of defatted or whole peanut paste, mixed with the spice cocktail, while sprinkling consists of dispersing the spice powder on the dried strips previously brined in oil.

The water-soluble and/or oil-soluble spice components will diffuse within the matrix, but at the same time, the solid particles will coat the dried meat strips. All of this contributes to the construction and development of the *kilishi*'s flavor. In Maroua and Garoua, peanut cakes are used exclusively because peanuts are sold as seeds, and peanut oil is traditionally extracted for commercialization [7]. The use of peanut cake as a matrix in the *kilishi* coating ingredient cocktail may appear as a form of valorization of the oil extraction residue, similar to the cake sticks called "Bacourou" in hausa. In Garoua and Maroua, the oil is added to the coating sauce to improve the flavor and appearance (shine). The coating quality indicators are based on the cocktail preparation method (Figure 9), which includes compliance with the dosage, the homogeneity of the mixture, the flavor released by the cocktail, the softening of the strips, and the adherence of the ingredient cocktail (Figure 8), which constitute the main criteria to be respected during the coating process. These criteria inevitably have an impact on the final organoleptic quality of the *kilishi*. The ingredient cocktail must also contribute to the softening of the strips and adhere effectively to the muscle cells, which initially requires good characteristics of tenderness, muscle aging, and the drying rate of the strips.

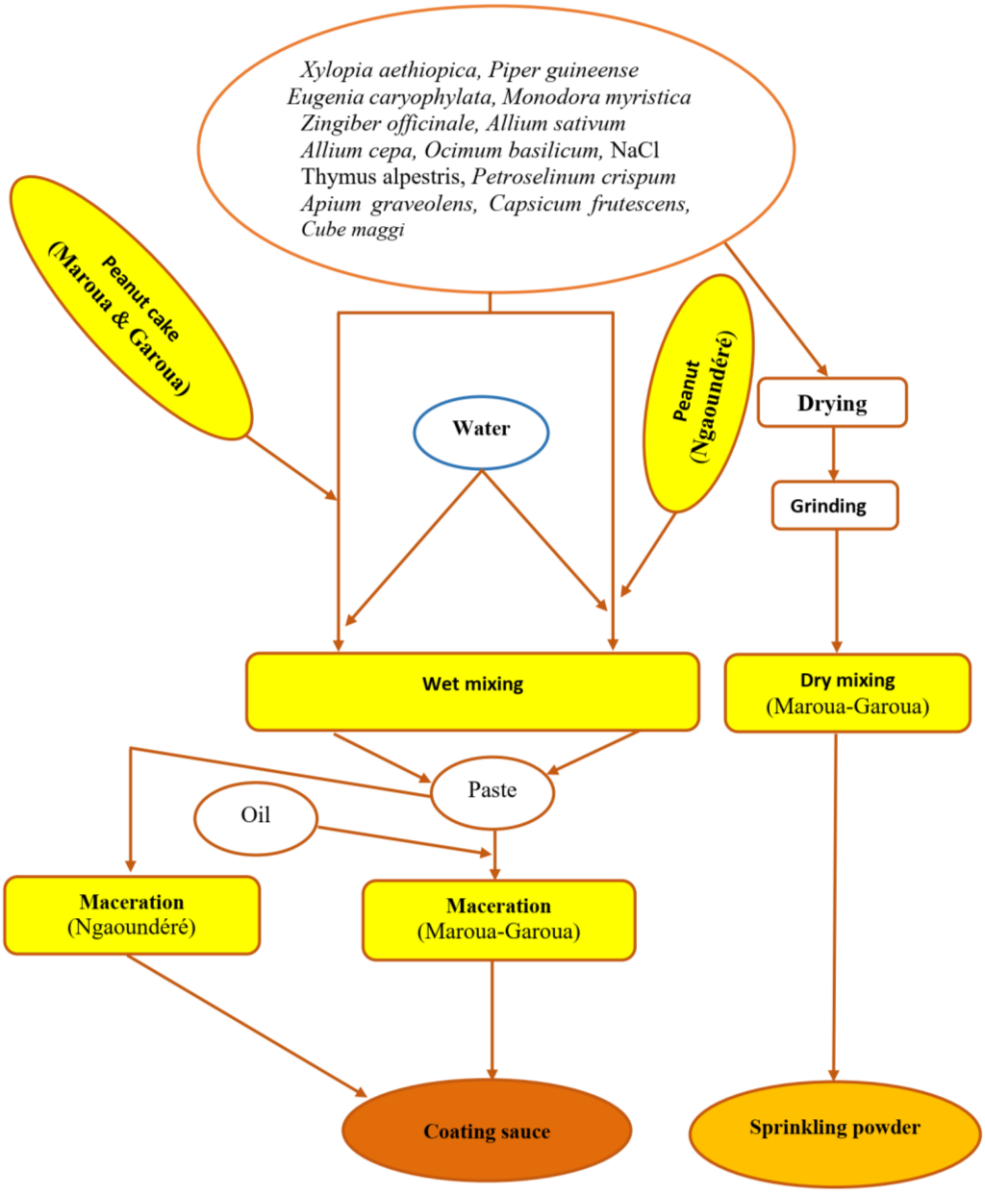

Figure 8. *Coating sauce and sprinkling powder preparation protocols.*

Figure 9. *Coating quality indicators.*

The coated strips are generally dried for 3 to 4 hours in the sun to remove residual moisture inherent in the coating and ensure the dryness of the *kilishi*. The drying supports are either a mat of raffia stems covering the wooden tables or a rope.

3.2.7. Roasting

While the coated and sun-dried strip constitutes the *kilishi*, in the traditional Hausa sense, the majority of operators, including the Hausa, add a complementary roasting operation. The temperature is around 90 ℃ for approximately 5 minutes, with the aim of developing the product's appearance (characteristic color and shine), texture (brittleness), and flavor (Figure 10). The characteristic color (brown with shades of color) obtained confirms that reported by [2, 13]. This color is developed during the Maillard reactions, characterized by the appearance of brown pigments and a golden crust. The quality of this operation is based on the following indicators: characteristic color, the flavor that emerges, friability, shine and roasting time with the preeminence of the characteristic color.

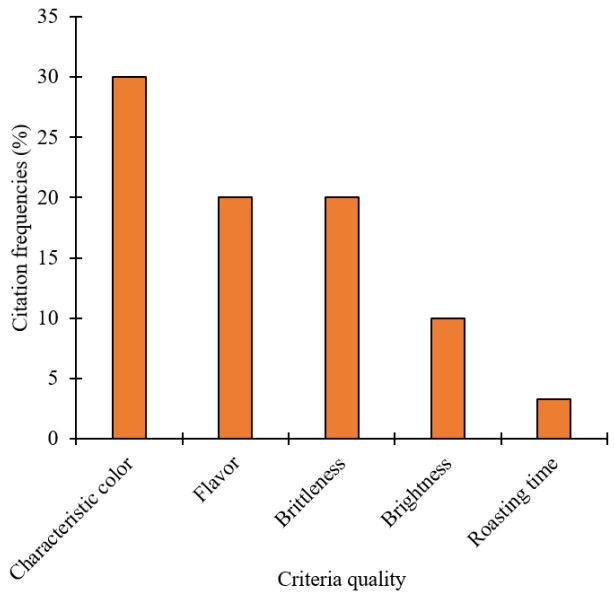

Figure 10. *Roasting quality indicators.*

3.2.8. *Kilishi* Quality

Quality indicators at the intermediate stages of the process reflect the operators' approach to constructing the final quality of the *kilishi*. They implement their technical practices with the aim of obtaining a final product characterized by its flavor, texture (tenderness, friability, spice adherence, low hole density), and shelf life (Figure 11). The careful choice of raw material and the conditions for implementing the various unit operations determine the achievement of these objectives, which, moreover, meet consumer expectations (Figure 12). In this regard, evaluating *kilishi* at consumption provides a better understanding of its quality attributes. The texture of *kilishi* should be brittle and tearing to the touch, but tender, crumbly, elastic, and melt in the mouth (Figure 12). Although terminological groupings are possible, it seemed preferable to retain consumer vocabulary, as the terms used are likely to refer to sensory characteristics consistent with actual perception upon consumption.

Thus, the term "tearing" attributed by more than 30% of consumers to the texture of *kilishi* may possibly indicate meat whose strips break during handling along a path parallel to the muscle fibers; which could be similar to more regular unwinding in the same direction. As for the color of *kilishi*, three shades of color seem to characterize the product: brown, maroon, and red. The work of [2, 13] had already mentioned these colors as attributes for appreciating *kilishi* upon consumption. Furthermore, the qualifiers "light" and "golden" accompany these shades of color, probably highlighting the shine function sought by those involved in the production process during the grilling process. If compliance with the above criteria is favorable to the beneficial integration of *kilishi* into the market, consumers put the hygienic criterion in pole position in the acquisition of the product for consumption (Figure 13).

The current conditions of distribution of *kilishi*, exposed to the open air or summarily wrapped in kraft paper, constitute, in this respect, the main barrier to purchase and justify the low hygienic quality of the products found in urban markets [3, 6, 12]. This observation justifies that informed consumers prefer to buy *kilishi* directly in the production workshops, where the product is placed in glass or wire mesh cabinets.

Previous initiatives had been undertaken by research to remove these hygienic constraints [3-5] focused on the traditional process of manufacturing *kilishi*, with a particular emphasis on the packaging and storage methods of *kilishi*, in relation to the quality of the product. The problem of *kilishi* packaging for the markets therefore remains a significant challenge for the emergence of the product.

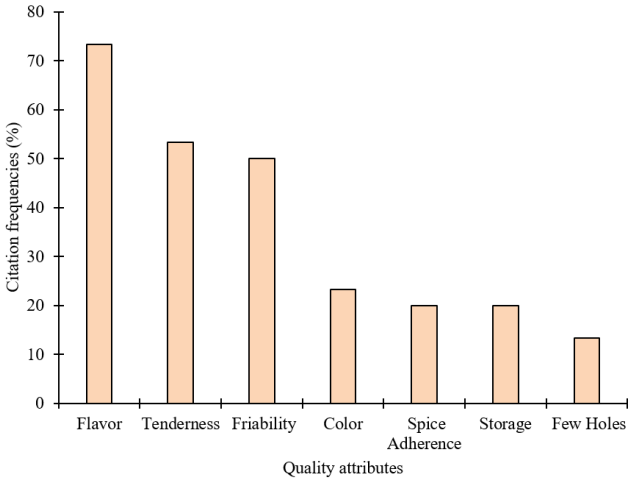

Figure 11. *Kilishi quality attributes.*

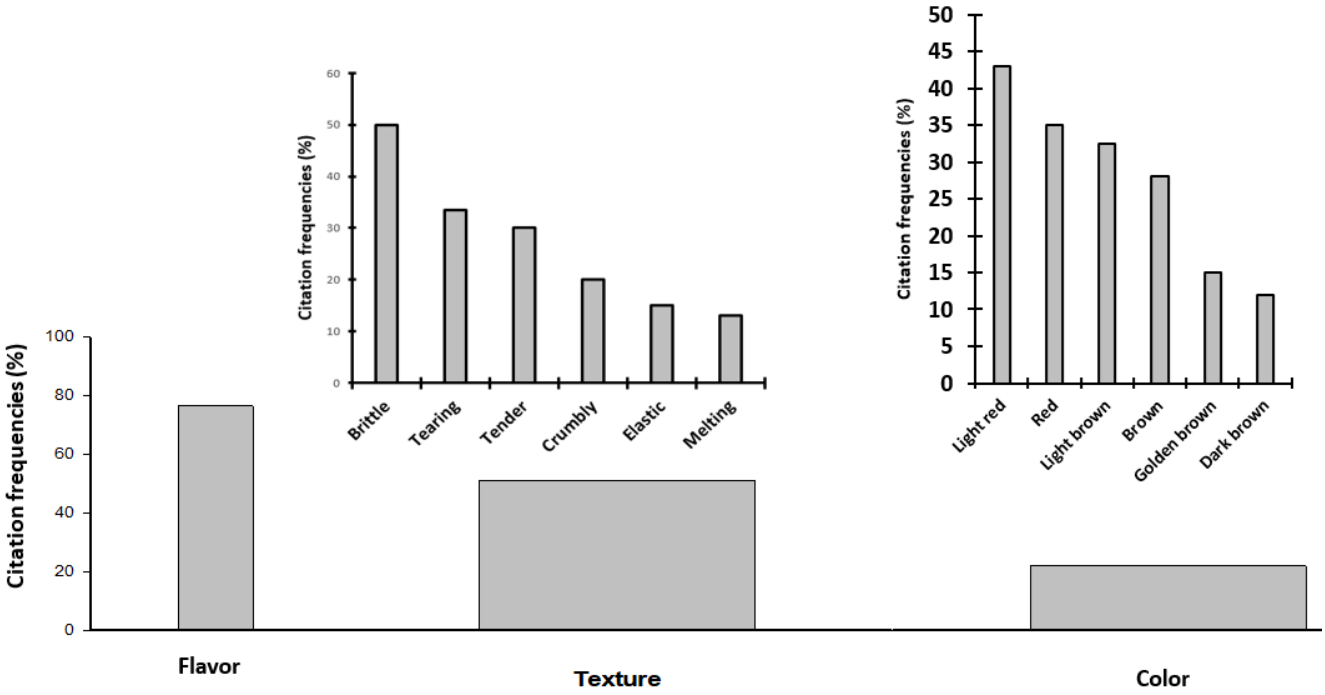

Figure 12. Quality criteria for kilishi for consumption.

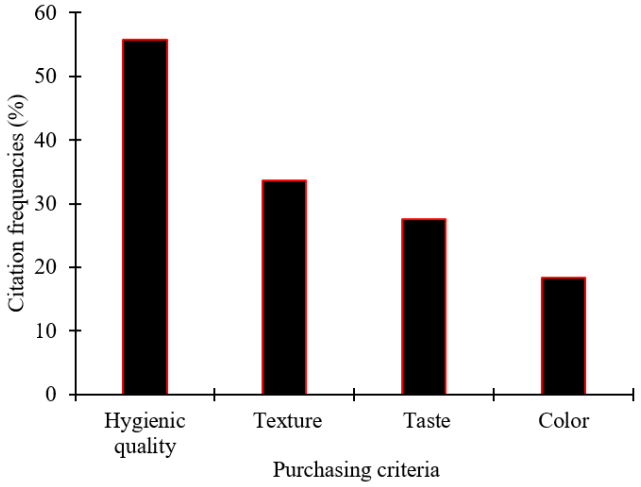

Figure 13. Criteria for purchasing kilishi.

Operators in the kilishi sector are aware of these issues, to the extent that they identify three groups of major constraints to be overcome for the emergence of the sector: i) the regularity of the quality of the raw material, ii) the scaling up of production practices and tools and, iii) the response to market requirements, in terms of packaging and preservation of the product (Figure 14).

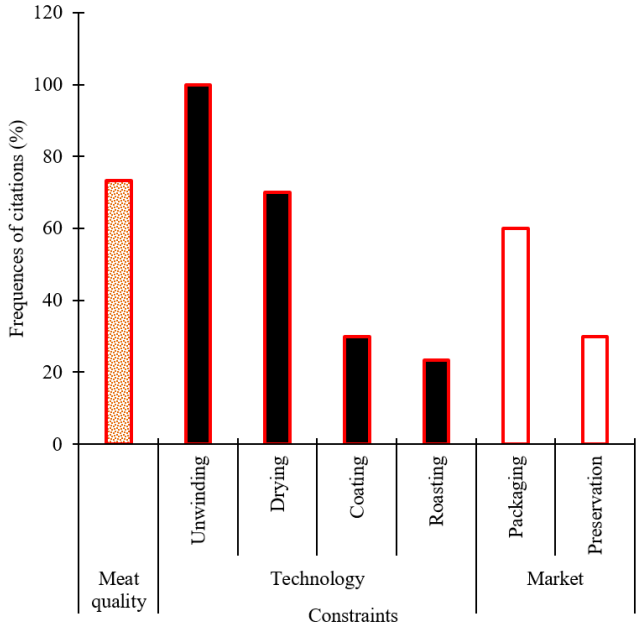

Figure 14. Major constraints of the kilishi production and distribution system.

4. Conclusion

The aim of this study was to gain a better understanding of the management of constraints and the construction of *kilishi* quality by production operators in the savannahs of Northern Cameroon, in order to identify the associated constraints and

avenues for improvement. This study shows that *kilishi* production is an exclusively male activity of which is carried out globally at over 80% by the Hausa. Technologically, all unit operations are subject to constraints, with meat unwinding and technological quality of meat coming in first place. Production actors have identified quality indicators that allow them to construct *kilishi* quality throughout the process, in terms of texture (tenderness and freshness of meat, friability of kilishi, spice adherence, low hole density), low fat content and flavor of kilishi. Therefore, mastering the construction of *kilishi* quality involves defining:

1. Firstly, measurable technological indicators;
2. Secondly, how to integrate and adjust these particular indicators in facilitating the improvement of safety, nutritional, organoleptic and marketable quality of *kilishi.*

Abbreviations

ERU	External Rotary Unwinding
L	Length
w	Width
t	Thickness

Conflicts of Interest

The authors declare no conflicts of interest.

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