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Endogenous Hygienic Practices and Health Risk Perception in the Artisanal Production of Attiéké

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Abstract

In Côte d'Ivoire, attiéké plays a major role in urban food consumption and in women's informal food economy. Its artisanal production often takes place under precarious hygienic conditions. Available microbiological studies report recurrent contamination; in some Abidjan markets, more than 90% of samples exceed CODINORM standards. This situation contrasts with local logics of cleanliness and risk management that remain insufficiently connected to formal public health approaches. This article analyses the endogenous hygienic practices associated with artisanal attiéké production and examines how producers perceive and manage the health risks related to their activity. The study is based on a qualitative secondary analysis of 14 scientific publications produced between 2004 and 2024, compiled from academic and institutional databases and examined through cross-thematic analysis. The results show that drying and packaging are the main critical contamination points, that cleanliness is defined through visible and sensory criteria rather than microbiological standards, and that immediate economic constraints relegate health risk to a secondary position. These findings argue for a participatory governance approach grounded in the endogenous logics of producers.

Keywords: *Attiéké; Endogenous Hygienic Practices; Health Risk Perception; Artisanal Production; Microbial Contamination; Côte d'Ivoire*

1. INTRODUCTION

Attiéké is one of the most emblematic foods of Ivorian cuisine. Derived from the fermentation and steam cooking of cassava semolina (Manihot esculenta Crantz), this food carries considerable nutritional, economic, and cultural significance for millions of households. Its recognition by UNESCO in 2024 as Intangible Cultural Heritage consecrates its status as a living cultural heritage (UNESCO, 2024).

Originally produced by the Lôdjoukrou, Alladjan, Ébrié, and Avikam communities of the lagoon regions, attiéké has progressively spread across West Africa and has since been exported to Europe and the Americas by the Ivorian diaspora (Assanvo et al., 2006).

The attiéké sector is organized around informal structures dominated by women who master traditional fermentation techniques and ensure the sale of finished products on urban and peri-urban markets. The transformation of cassava into attiéké involves seven successive stages (peeling, grinding, fermentation, 48 to 72 hours at room temperature, pressing, drying, steam cooking, and packaging) whose quality of execution directly conditions the microbiological and chemical profile of the final product (Ban Koffi et al., 2004; Kouam et al., 2019). Annual consumption is estimated between 28,000 and 34,000 tonnes, with 100 tonnes produced daily in Abidjan alone (Djeni et al., 2011). This economic magnitude contrasts sharply with the documented precarity of production conditions, which exposes the product to serious health risks at every stage of the chain.

Microbiological studies consistently report significant contamination in commercially sold attiéké. The presence of fecal coliforms, Staphylococcus aureus, and Bacillus cereus exceeding CODINORM regulatory limits has been documented in the majority of samples analyzed across Abidjan markets (Kouame et al., 2013; Kouam et al., 2019). Moreover, 75% of artisanal production sites present poor sanitary conditions without adequate infrastructure (Houédakor, 2016). These findings raise a fundamental question: to what extent do manufacturing practices contribute to this risk, and how do sector actors perceive and manage this danger in their daily professional lives?

This question is all the more relevant because the literature reveals a persistent gap between the microbiological risk objectified by laboratory analyses and producers' representations of acceptable hygienic practices. A study by Eba Bokobla (2020) among 31 heads of producer groups in the Abidjan district showed that disposing cassava waste into the lagoon was perceived not as a source of contamination, but as a sanitary act, illustrating the socio-cultural complexity that underlies hygienic practices in this sector. This article conducts a qualitative secondary analysis of the literature to identify the manufacturing practices that generate health risks and the social mechanisms through which these risks are perceived and managed endogenously.

2. METHODOLOGY

This study is based on a qualitative secondary analysis of the scientific literature, an approach that synthesizes and reinterprets results produced by other researchers to address a new research question (Heaton, 2004). It is distinguished from statistical meta-analysis by its interpretive character and theoretical aims. The documentary search was conducted across Scopus, Web of Science, Google Scholar, Cairn.info, African Journals Online, and FAOSTAT, using keywords combining the food object (attiéké, fermented cassava), the health dimension (microbiological quality, food safety, contamination), and the social dimension (hygienic practices, social representations, informal sector), covering the period 2004 to 2024. A corpus of 14 primary studies was retained after assessment of thematic relevance, addressing microbiological dimensions or the social practices and representations of sector actors in Côte d'Ivoire or comparable contexts.

Cross-thematic analysis following Braun and Clarke (2006) was applied in two phases: a transversal reading identified themes related to concrete practices and contamination factors, while a second reading extracted themes related to social representations of risk and endogenous logics of risk management. These two axes were subsequently articulated within an integrated analytical perspective, enabling a dialogue between the microbiological evidence base and the sociological literature on risk perception and informal food systems.

3. RESULTS

3.1 Concrete Manufacturing Practices as Risk Vectors

3.1.1 Critical Stages of the Production Process

The transformation of cassava into attiéké involves seven main stages, several of which present high microbiological risk profiles documented in the literature. The identification of critical control points (CCPs) by Kouam et al. (2019) in artisanal units in Abidjan, Dabou, and Jacqueville established that grinding, fermentation, pressing, drying, cooking, and packaging constitute CCPs whose control directly determines sanitary quality. The cassava root itself already presents Bacillus cereus counts of approximately 1.2×10^5 CFU/g and total coliform counts reaching 1.6×10^4 CFU/g, illustrating that contamination is present upstream of the transformation process (Kouam et al., 2019).

Fermentation produces acidification that eliminates coliforms and reduces S. aureus counts, but does not eliminate B. cereus or its heat-resistant spores (Kouam et al., 2019). Steam cooking at 88 ± 3.22°C for 35 ± 1.37 minutes eliminates all vegetative microbial forms, yet B. cereus spores persist at 1.1×10^2 CFU/g. Drying constitutes a paradoxical critical point: the semolina is exposed to the sun directly on the ground or in wicker trays placed on used tires, favoring contamination by dust, insects, and domestic animals. Packaging represents the most documented post-cooking contamination stage: all microbial loads eliminated by cooking reappear in commercially sold attiéké. An analysis of 375 samples in five Abidjan markets revealed aerobic mesophilic bacteria counts of 2.2×10^5 to 3.4×10^6 CFU/g and S. aureus reaching 3.8×10^4 CFU/g at the Siporex market, far exceeding regulatory standards (Kouame et al., 2013).

The comparison between attiéké packaged hot immediately after cooking (which presents satisfactory microbiological quality with no detectable pathogenic bacteria) and the same product sold under standard market conditions (which contains 1.7×10^6 bacteria/g), demonstrates that traditional techniques, when optimally executed, can deliver a microbiologically safe product. The problem lies not in the techniques per se, but in the conditions under which the product travels from producer to consumer. The reheating of unsold attiéké, a widespread commercial practice, amplifies this risk further: B. cereus spores germinate when stimulated by heat and subsequently multiply in the product cooled to room temperature, raising the proportion of contaminated samples from 20% at 1 to 2 days of sale to 28.2% at 3 to 5 days (Houédakor, 2016).

3.1.2 The Production Environment and Post-cooking Contamination

Microbiological analysis of utensils used in production reveals particularly high counts: total coliforms of 4.6×10^3 CFU/cm² on drying trays, S. aureus at 2.5×10^3 CFU/cm² on spatulas, and molds on all contact surfaces (Kouam et al., 2019). These results are directly linked to the state of the equipment: 87.5% of producers use hard plastic or aluminum basins with scratched surfaces from intensive use, whose abrasions constitute favorable niches for microbial biofilm formation (Houédakor, 2016). The study by Eba Bokobla (2020) among 31 producers in the lagoon villages of Anan, Blockhaus, and Abobo-Doum documented the use of water drawn from wells dug at the edge of the lagoon for production and utensil washing, a practice that directly introduces lagoon microorganisms into the manufacturing process, given that the Ébrié lagoon receives untreated domestic and industrial effluents daily.

Houédakor (2016) showed that the microbiological quality of freshly prepared attiéké is strongly correlated with the sanitary condition of the production site ($p < 0.05$), with 100% of samples from the Anoumambo site contaminated by B. cereus, compared to 0% at the Avocatier site where drying was performed on raised racks. Chemical contamination constitutes an additional dimension of risk: lead concentrations of 2.2 to 4.5 mg/kg depending on locality, exceeding FAO/WHO thresholds, have been attributed to diesel-powered grinding machines that are insufficiently maintained (Kouam et al., 2019).

The distribution of attiéké from production zones to Abidjan markets by porterage, carts, and vans (often mixed with other goods in the same vehicles) further increases exposure to cross-contamination throughout the chain (Aka, 2013).

3.2 Endogenous Perception of Health Risk

3.2.1 The Differentiated Construction of Cleanliness and Danger

Analysis of the literature reveals that attiéké producers construct the notion of cleanliness based on a fundamental distinction between the private production space (the shed or immediate workspace) and the surrounding public space, primarily the lagoon in the villages of the Abidjan district. Eba Bokobla (2020) showed that sanitation is associated, in the representations of these women, with the cleanliness of the immediate workspace, while the disposal of cassava waste into the lagoon is perceived as a sanitary act that clears the space of cumbersome residues. This logic produces an apparent paradox: producers carefully maintain the visible cleanliness of their production shed while using water from wells contaminated by the lagoon for the manufacturing process. This paradox illustrates a socially specific construction of danger that does not correspond to formal microbiological categories.

This differentiated perception rests on several interdependent social representations. Cassava residues dumped into the lagoon are perceived as feeding fish species rather than polluting the aquatic environment, which cognitively neutralizes producers' sense of environmental responsibility (Eba Bokobla, 2020). The lagoon is also represented through a mystical register by some producers, as a divine creation incapable of degrading, which morally grounds the use of its water for food production. Furthermore, a representation of public responsibility entirely delegates to municipal authorities the charge of maintaining the lagoon environment, which relieves producers of any personal obligation in this regard. These representations do not constitute isolated beliefs, but coherent and shared systems that collectively orient the daily practices of all the producers surveyed.

3.2.2 Sensory Evaluation as a Criterion of Health Quality

Producers and consumers mobilize elaborated sensory competencies (based on smell, sight, and touch) to evaluate the quality and safety of the product, as a substitute for or complement to formal microbiological criteria. An attiéké whose fermented smell, whitish color, and grainy texture correspond to internalized organoleptic standards is considered safe regardless of its actual microbial load. This sensory evaluation presents some partial coherence with available scientific data: Djeni et al. (2011) established that sensory parameters such as aromatic acidity (lactic acid content ranging from 59.9 to 110.5 mg/100 g) correspond to measurable biochemical indicators, suggesting that producers' sensory knowledge system captures real aspects of the biochemical quality of the product. However, the microbiological quality of attiéké deteriorates beyond three days of storage at room temperature without this deterioration being necessarily perceptible through conventional organoleptic indicators (Djeni et al., 2011). Chemical contamination by heavy metals is entirely invisible to the senses and cannot be detected by any sensory indicator (Kouam et al., 2019).

3.2.3 Risk Hierarchization and the Rationality of Precarity

The persistence of potentially risky practices does not reflect indifference to danger, but a social hierarchization of risks in which health risk is systematically relegated behind more immediate economic concerns. The activity of producing and selling attiéké generates between 20 and 70 billion CFA francs per year in the sector (Houédakor, 2016), making economic risk far more tangible than diffuse, deferred microbiological risk. A study on attiéké vending in three Burkina Faso cities found that 68% of 300 vendors displayed poor hygienic practices and had never received food safety training (Ouédraogo et al., 2021). The predominance of economic constraints over health concerns does not reflect collective irrationality, but pragmatic management of uncertainty in resource-limited environments where structural determinants (inadequate water access, absence of refrigeration, lack of adapted workspaces) lie beyond individual producers' control (Houédakor, 2016).

3.2.4 Representations of Fermentation as a Safety Process

In producers' endogenous frame of reference, fermentation is perceived not as a process potentially generating residual microbiological risks, but as a positive transformation step that purifies the raw material and guarantees the distinctive organoleptic quality of the final product. This representation is grounded in accumulated experience of perceptible effects (pH lowering, aromatic acidity development, dough softening) and intergenerational know-how transmission. It presents partial coherence with microbiological data: fermentation effectively eliminates coliforms and reduces S. aureus through the bacteriostatic activity of organic acids produced by lactic acid bacteria (Djeni et al., 2011; Kouam et al., 2019). However, it obscures the limits of fermentation as a microbiological barrier: B. cereus spores persist at 3.9×10^5 CFU/g in fermented dough, and fermentation provides no protection against chemical contamination by heavy metals (Kouam et al., 2019). What producers perceive as a comprehensive safety step constitutes microbiologically only a partial risk reduction, not its elimination.

3.3 Endogenous Hygienic Practices between Transmission and Adaptation

Hygienic practices in the artisanal attiéké sector result from a codified set of gestures and routines transmitted intergenerationally by women of the lagoon communities. Djeni et al. (2011) documented remarkable homogeneity of biochemical and sensory characteristics within the production zones of the Lôdjoukrou and the Alladjan (no significant variation, $p > 0.05$, among six sites per region), attesting to faithfully transmitted know-how. This contrasts with higher variability among Ébrié producers who modified the traditional process in response to urban market pressures (using a reduced inoculum and eliminating granulation and drying stages) resulting in greater qualitative diversity and increased microbiological vulnerability (Djeni et al., 2011). Analysis of the traditional inoculum by Kastner et al. (2010) showed negligible mycotoxin contamination (maximum ochratoxin A of 0.2 µg/kg, ten times below European limits), suggesting that certain traditional practices possess an implicit microbiological efficacy that merits greater recognition in health governance policies. The progressive adoption of plastic packaging by some producers illustrates a form of normative hybridization, though it introduces a specific risk related to the use of non-food-grade bags whose chemical components can migrate into the product upon sun exposure (Ban Koffi et al., 2004).

4. DISCUSSION

4.1 A Multi-stage Contamination Chain and a Coherent Endogenous Rationality

The secondary analysis reconstructs a multi-stage contamination chain in which each production stage contributes in varying proportions to the final microbial load. Grinding introduces microorganisms from tuber surfaces; fermentation constitutes a critical point for B. cereus whose spores resist acidification; open-air drying exposes the semolina to the most significant environmental contamination; cooking eliminates vegetative forms but leaves B. cereus spores; packaging and distribution reintroduce all eliminated microorganisms. This reconstruction converges with the HACCP analysis of Kouam et al. (2019), who identified seven CCPs corresponding precisely to these stages. Mastering these CCPs requires material and organizational conditions absent in the vast majority of artisanal units. Contamination is not primarily the product of producers' bad intentions, but of structural production conditions that make the management of microbiological risks particularly difficult, a finding echoed by Houédakor (2016), who showed that the sanitary state of the production site is the factor most strongly correlated with attiéké contamination ($p < 0.031$).

In parallel, the analysis reveals a fundamental gap between two coexisting risk regimes. Expert microbiological risk is defined by quantifiable thresholds codified in CODINORM and the Codex Alimentarius. Producers' perceived risk is constructed through social representation systems that define cleanliness and danger according to different criteria, anchored in daily production experience and culturally transmitted values. These epistemologies are not incompatible, but they produce divergent

conclusions about the nature and intensity of danger under ordinary production conditions. The lagoon village producers' case illustrates this paradigmatically: cleanliness defined by the absence of visible and olfactory dirt is a coherent and socially shared definition, one simply insufficient to prevent invisible microbiological risks. This epistemological gap has direct practical consequences: food safety interventions communicated through laboratory reports and normative training programs often speak past their intended audiences, who navigate a different risk regime validated by market outcomes and embodied practice. Effective interventions must translate microbiological evidence into categories producers actually use sensory indicators, economic outcomes, and community-validated procedures.

4.2 Implications for Participatory Health Governance

The results raise important implications for the design of food safety policies. The literature on African informal food sectors consistently shows that prescriptive and technocratic approaches (which impose formal standards without accounting for actors' endogenous logics) produce limited effects and often generate resistance (Mensah & Julien, 2011). The fact that 68% of vendors surveyed in Burkina Faso had never received food safety training illustrates the limits of a purely normative approach (Ouédraogo et al., 2021). Effective health governance should rest on three complementary axes: first, valorizing endogenous hygienic practices as a starting point for interventions, recognizing that producers possess real know-how with documented microbiological efficacy in certain components, such as mastery of fermentation; second, adopting participatory approaches that involve producers in defining intervention modalities, leveraging producer associations as dissemination relays; third, addressing objective material constraints by investing in basic infrastructure (potable water, adapted drying spaces, food-grade utensils)without which normative training remains inoperative. The measure proposed by Houédakor (2016) of reheating attiéké to at least 90°C for 15 minutes (reducing B. cereus spores from 4.2 to 1.8 log CFU/g) illustrates how an intervention built on existing practices can produce significant health effects without disrupting producers' endogenous logics.

5. CONCLUSION

The secondary analysis of available scientific literature establishes that health risks in artisanal attiéké production do not stem from arbitrary practices, but from a structural tension between precarious material conditions, endogenous hygienic logics coherent within their own frame of reference, and risk perception systems that hierarchize dangers differently from formal microbiological frameworks. Each stage of the process constitutes a potential contamination vector whose management requires material conditions that are lacking in the vast majority of artisanal units. Endogenous risk perception (constructed from sensory evaluation and the hierarchization of economic imperatives over health concerns) produces a persistent gap between objectified and perceived risk that prescriptive interventions alone cannot bridge.

These results argue for a governance approach that takes seriously the endogenous logics of actors and builds upon them as resources for improving practices, rather than treating them as obstacles to overcome. Such an approach requires simultaneous investment in production infrastructure, participatory training of producers, and ethnographic field research to more precisely document the diversity of practices and representations across production zones. The corpus available is predominantly composed of quantitative microbiological studies; qualitative studies on social practices and representations remain few. Most are cross-sectional and do not capture evolving practice dynamics, particularly in response to the transformations linked to the UNESCO inscription of 2024. These gaps define a research agenda for which food ethnography is particularly well positioned.

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