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Food safety awareness, risk perception, and attitudes toward traceability of *Ponmo*: a One Health perspective

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ABSTRACT

Ponmo is widely consumed in Nigeria, and its unsafe processing practices may expose consumers to potential microbiological and chemical hazards. This study used cross sectional online survey of adults (age ≥ 18 years) who consumed *ponmo* and lived in Nigeria in 2026. Participants were recruited using a non-probability convenience sampling technique. Food safety awareness, food safety risk perception, and attitudes towards traceability were measured using a structured questionnaire. Risk perception was assessed using a nine-item, five-point Likert scale with good internal consistency (Cronbach's $\alpha = 0.842$). Data were analysed using descriptive statistics, while the Mann–Whitney U and Kruskal–Wallis H tests were used at a 0.05 level of significance. The majority of respondents were aware that improperly processed animal products could transmit disease (93.3%), that improperly processed *ponmo* could be harmful to health (84.4%), and that burning tyres and plastics during processing could cause harm to health (90.4%). The strongest association with risk perception was observed for awareness of chemical residue persistence ($\chi^2 = 36.877$, $p < 0.001$), followed by awareness of tyre use and singeing ($p = 0.001$), and awareness of plastic use and singeing ($p = 0.001$). Hazard-specific awareness was significantly associated with food safety risk perception, indicating that reinforcing food safety education through targeted approaches, traceability, and safer food processing methods in a one health context may contribute to consumer protection and public health. These results should be considered in the context of the online convenience sample, which was mainly highly educated and might not be representative of consumers with limited access to the Internet or lower levels of education.

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1. Introduction

Consumption of processed skin from cattle (*ponmo*) is common in Nigeria due to its affordability, unique texture, traditional usage, and accessibility to people of different income levels. Conventional animal protein foods may become even more expensive, and this may further drive the demand for *ponmo* as an alternative food source (1).

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However, its safety is an area of concern due to the insecure nature of its informal processing involving the use of discarded vehicle tyres, plastics, used engine oil, and any combustible wastes for singeing. These practices can introduce toxic contaminants to the product, as well as result in environmental pollutants that pose a risk to processors, surrounding communities, consumers, and ecosystem health (2).

Chemical contamination is an important issue with regard to food safety related to unsafe processing of *ponmo*. In Nigeria, earlier studies revealed significantly higher concentrations of toxic metals such as lead, chromium, mercury, and arsenic in cowhides burned with tyres, plastics, and other waste fuels as compared to the cowhides burned by boiling and shaving (3). Recent studies further confirmed the persistence of the issue. Processed cowhides from the State of Ogun had a high concentration of arsenic, chromium, and lead, and the estimated health risk was found to be higher than the internationally recommended safety limits (4). This is consistent with other reports from West Africa. In Ghana, products made with tyre-singed cowhide had much higher quantified amounts of carcinogenic polycyclic aromatic hydrocarbons (PAHs) than those made with firewood or liquefied petroleum gas (LPG) and the highest estimated lifetime cancer risk for consumers (5). Similarly, meat that was singed using tyres also contained higher levels of PAHs and estimated dietary exposures than meat that was processed using LPG and firewood (6). These studies revealed the potential of exposure to toxic contaminants to be higher due to unsafe singeing practices.

Another significant issue is microbiological hazards. Microbial contamination of ready-to-eat *ponmo* may be possible during slaughtering, processing, transportation, retail display, and post-processing handling as a result of poor hygiene practices. Ready-to-eat *ponmo*, sold by street vendors in Nigeria, has been found to contain *Staphylococcus aureus*, *Escherichia coli*, *Bacillus* spp., and *Proteus* spp. (7). In Lagos, 41.7% of the ready-to-eat *ponmo* samples were positive for coagulase-positive *S. aureus,* and all confirmed isolates were found to possess enterotoxin genes associated with staphylococcal food poisoning (8). Recently, high levels of microbial counts and multidrug-resistant *E. coli*, *S. aureus*, *Klebsiella* spp., and *Pseudomonas* spp. were detected in marketed *ponmo* (1). As a result, consumers could be exposed to multiple chemical contaminants, foodborne pathogens, and antimicrobial-resistant bacteria at once.

Ponmo safety should be considered in relation to the One Health approach because of the fact that chemical contaminants, biological hazards, environmental pollution, and consequences for human health are all present. One Health understands the interconnectedness of human, animal, plant, and environmental health and encourages collaborative, multi-sectoral efforts to maximise health and wellbeing (9). Therefore, enhancing *ponmo* safety needs coordination between the various sectors related to livestock production, food processing, environmental management, regulation, surveillance, and involvement of the consumers. However, there are still knowledge gaps and preparedness deficits in Nigeria, especially for emerging zoonotic diseases and

environmental health, which require multidisciplinary teamwork and coordinated public education (10). Awareness and risk perception are key elements of food safety risk management. Research in Nigeria has revealed that consumers might only be aware of general food safety threats and not know the specific ways foods might be contaminated. Less than half of the meat consumers in Ilorin had sufficient food safety knowledge, with higher educational level being correlated with higher food safety knowledge (11). One study in Nigeria determined that the source and processing of meat was more important to food safety risk perception than general food safety knowledge (12). Other studies support these findings and suggest a potential mediating role for food safety risk perception between knowledge and safer food-handling habits (13). The results indicate that knowledge about certain risks related to *ponmo* could be relevant in consumers' food safety risk perception. Another element of food safety management that is possible is food traceability. Traceability provides the ability to trace products through the chain and can also offer data regarding the origin, processing, and flow of the products (14). This may be especially applicable to traditionally processed products where the processing method may be less easy for consumers to verify. A recent meta-analysis of 72 peer-reviewed studies revealed that consumers were willing to pay a premium price for traceable food products, especially for traceable meat, and had a higher willingness to pay in the developing world (15). These findings revealed that consumers value traceability as it is very important, but there is a need for further studies to understand how effective traceability can be in supporting the safety of *ponmo*.

Although the evidence of the potential chemical and microbiological risk of improperly processed *ponmo* continues to grow, little research has been conducted on consumers' awareness of those specific risks, their perceptions of the related health risks and their attitudes towards traceability. Previous Nigerian consumer research has mainly concentrated on general food safety knowledge and risk perception among consumers who buy their meat from retail outlets, while a few studies have concentrated on contamination, microbiological quality and exposure in relation to *ponmo*. The novelty of the present study was the combination of food safety awareness, food safety risk perception and attitudes towards traceability within the One Health approach, at a *ponmo*-specific level. This consumer-centric approach offers initial evidence to guide food safety education, traceability, and One Health interventions for *ponmo* safety in Nigeria.

This study is conceptually based on the One Health approach, as it considers the various factors affecting the safety of *ponmo*: human, animal, and environmental. Unsafe processing practices can introduce microbial and chemical hazards into *ponmo* and contribute to environmental contamination, with potential implications for human, animal, and environmental health. Within this One Health context, the present study examined the association between consumers' awareness of specific food safety concerns associated with *ponmo* and their food safety risk perception. The study also assessed consumers' attitudes towards food traceability as a separate

component of *ponmo* food safety management. The conceptual framework in this study is presented in Fig. 1.

Thus, we hypothesised that the higher the consumer's awareness of the food safety concerns about *ponmo*, the more they believed in the increased food safety risk associated with *ponmo*. In addition, the study assessed consumers' attitudes towards food traceability. This study, therefore, assessed food safety awareness and its association with risk perception, as well as attitudes towards food traceability, from a One Health perspective among consumers of *ponmo* in Nigeria.

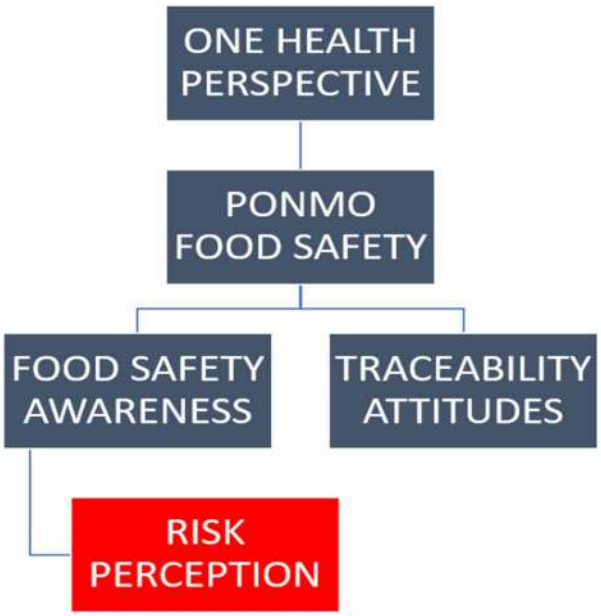


Figure 1. The conceptual framework

2. Materials and Methods

2.1. Study design and participants

The cross-sectional online survey was carried out from April to June 2026 to determine food safety awareness, risk perception, and attitudes of Nigerian consumers towards *ponmo* traceability. This survey was part of a larger study to explore consumer perceptions of food safety and One Health issues related to the consumption of *ponmo*. The eligible participants consisted of adults (18 years and above) who reside in Nigeria, consumed *ponmo*, and were willing to participate in the study. Individuals who did not consume *ponmo*, refused informed consent, or had incomplete questionnaires were omitted from analysis.

2.2. Sampling and data collection

A non-probability convenience sample was recruited through an online questionnaire administered via Google forms and distributed through WhatsApp. Participation was voluntary, with one response permitted per participant. After screening, 405 complete and non-duplicate responses were retained. There was no a priori sample-size calculation. The achieved sample size was similar to the conventional population size of 384 for cross-sectional surveys with a 95% confidence level, 5% precision, and 50% expected proportion. Previous Nigerian consumer studies have used comparable or larger samples, including 327 meat consumers (12) and 869 consumers in Ilorin (11). Given the non-probability sampling approach, this comparison is provided only as methodological context and does not imply population representativeness.

2.3. Questionnaire development

Data were collected using a structured, self-administered questionnaire developed from published literature on food safety awareness, consumer risk perception, One Health, and food traceability. It comprised sections on socio-demographic characteristics, food safety awareness, risk perception, and attitudes towards traceability.

Before nationwide administration, the questionnaire was reviewed by researchers with expertise in food safety and public health for face and content validity and pretested among a small group of *ponmo* consumers who were excluded from the final study. Minor modifications were made to improve clarity and readability.

Food safety risk perception was assessed using ten five-point Likert-scale statements ranging from 1 (strongly disagree) to 5 (strongly agree). The statements addressed food safety concerns associated with *ponmo*, traceability, regulatory expectations, and related consumer perceptions. Internal consistency was assessed using Cronbach's alpha. One item with a corrected item-total correlation <0.30 ("I trust that the *ponmo* I buy has been safely processed") was excluded. The remaining nine items were averaged to obtain the composite risk perception score, which demonstrated good internal consistency (Cronbach's $\alpha = 0.842$).

The nine retained statements were: (1) "I would like to know the origin (source) of the *ponmo* I consume"; (2) "Consumers should be informed about where *ponmo* comes from"; (3) "Government should regulate *ponmo* processing and sale more strictly"; (4) "Only *ponmo* from veterinary-inspected animals should be sold"; (5) "I am concerned about the safety of *ponmo* currently sold in markets"; (6) "Traceability of animal products such as *ponmo* is important for public health"; (7) "Labelling *ponmo* with source and processing information would influence my purchase"; (8) "Poor *ponmo* processing practices are a public health concern in Nigeria"; and (9) "The One Health approach (linking animal, human, and environmental health) is relevant to *ponmo* safety".

2.4. Study variables

The main outcome was the composite food safety risk perception score. Food safety awareness of animal products as a source of disease, zoonotic diseases, tyres or plastics used during singeing, potential health effects of singeing, persistence of chemical contamination after processing and health risks of improperly processed ponmo were used as explanatory variables. Socio-demographic characteristics were summarised as age, sex and educational attainment.

2.5. Statistical analysis

Data were subjected to descriptive and inferential statistics using the IBM SPSS Statistics version 27 software package (IBM Corp., Armonk, NY, USA), and data visualisation was carried out using RStudio (4.6.1). The participant characteristics and food safety awareness were presented in descriptive statistics. The risk perception score was not normally distributed, and nonparametric procedures were therefore employed. Groups with two and three categories of responses were compared using the Mann–Whitney U test and the Kruskal–Wallis H test, respectively, at the $p < 0.05$ level of statistical significance.

2.6. Ethical considerations

The participation of each respondent was voluntary and anonymous, and informed consent was electronically obtained prior to access to the questionnaires, which gave the participants a choice to discontinue their participation. However, ethical approval was not formally obtained in advance of data collection from formal institutions, and this is recognised as a limitation.

3. Results

The analysis of the data comprises 405 responses. The socio-demographic information of the respondents is presented in Table 1. Most of the participants were female (56.3%), and most of them were in the age group of 26 to 35 (69.6%). Education level was high, with 99.3% having tertiary or postgraduate qualifications.

Table 2 shows the food safety and public health awareness of the food safety respondents about *ponmo*. Overall, awareness of food safety hazards associated with *ponmo* was high. The majority of respondents were aware that improperly processed animal products can lead to the spread of disease (93.3%) and felt that improperly processed *ponmo* also has a health risk (84.4%). The awareness of using tyres, plastics, or any other waste in the singeing process (67.4%) was less than the awareness of the health effects of such practice (90.4%). Similarly, 77.0% of the respondents were aware of zoonotic diseases, while 82.2% were aware that chemical residues can be present in the *ponmo* if the processing is not properly done.

Figure. 2 presents self-rated knowledge of *ponmo* food safety by the respondents, and Figure. 3 shows the responses to the statements on *ponmo* traceability, food safety, and One Health by the respondents. The responses tended to be at the agree end of the Likert scale, but also showed a wider range of scores for statements on traceability than for those on food safety and One Health.

The respondents' food safety risk perception scores were compared across their food safety awareness scores in Table 3. Out of the six awareness variables, 5 variables were significantly associated with the risk perception ($p<0.05$). Awareness of chemical residues which may be found in the improperly processed *ponmo* showed the highest association with risk perception ($\chi^2 = 36.877$, $p < 0.001$, $\varepsilon^2 = 0.087$). Significant associations were also observed for awareness of tyre/plastic singeing ($U = 14{,}193.0$, $p = 0.001$, $r = 0.173$), belief that improperly processed *ponmo* poses a health risk ($\chi^2 = 11.703$, $p = 0.003$, $\varepsilon^2 = 0.024$), belief that tyre/plastic singeing harms health ($\chi^2 = 9.173$, $p = 0.010$, $\varepsilon^2 = 0.018$), and awareness of zoonotic diseases ($U = 11{,}628.0$, $p = 0.004$, $r = 0.145$). This was in contrast to the awareness that improperly processed animal products can cause disease, which was not significantly associated with risk perception ($U = 4518.0$, $p = 0.317$, $r = 0.050$). For the three awareness variables for which "Not sure" was a response option, the mean rank of "Not sure" was lower than the "Yes" or "No" option.

S1: I would like to know the origin (source) of the ponmo I consume; S2: Consumers should be informed about where ponmo comes from; S3: Government should regulate ponmo processing and sale more strictly; S4: Only ponmo from veterinary-inspected animals should be sold; S5: I am concerned about the safety of ponmo currently sold in markets; S6: Traceability of animal products such as ponmo is important for public health; S7: Labelling ponmo with source and processing information would influence my purchase; S8: Poor ponmo processing practices are a public health concern in Nigeria; S9: The One Health approach (linking animal, human, and environmental health) is relevant to ponmo safety.

Table 1. Socio-demographic characteristics of the respondents (N = 405)

Variable	Category	N	%
Gender	Male	177	43.7
	Female	228	56.3
Age (years)	18–25	30	7.4
	26–35	282	69.6
	36–45	57	14.1
	46–55	24	5.9
	>55	12	3.0
Highest education	Secondary	3	0.7
	Tertiary (NCE/OND/HND/B.Sc.)	204	50.4
	Postgraduate (PGD/M.Sc./Ph.D.)	198	48.9

Table 2. Food safety and public health awareness regarding *ponmo* among respondents (N = 405)

Awareness item	Response	N	%
Improperly processed animal products can transmit disease to humans	Yes	378	93.3
	No	27	6.7
Heard of zoonotic diseases	Yes	312	77.0
	No	93	23.0
Belief that improperly processed *ponmo* can pose health risks	Yes	342	84.4
	Not sure	30	7.4
	No	33	8.1
Aware some processors use burning tyres/plastics/waste during singeing	Yes	273	67.4
	No	132	32.6
Belief that burning tyres/plastics during processing may harm health	Yes	366	90.4
	Not sure	21	5.2
	No	18	4.4
Aware chemical residues may remain in *ponmo* after improper processing	Yes	333	82.2
	Not sure	54	13.3
	No	18	4.4

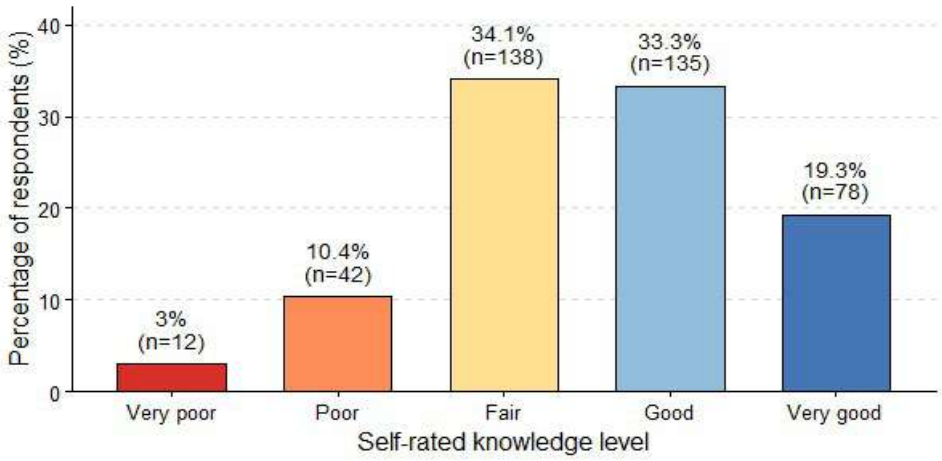


Figure 2. Self-rated knowledge of *ponmo* food safety among respondents (N = 405)

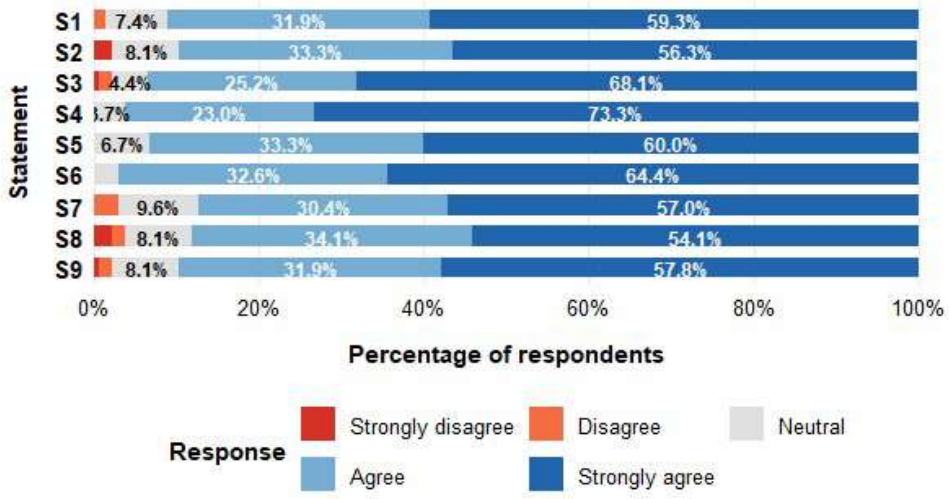


Figure 3. Respondents' perceptions of ponmo traceability, food safety, and One Health (N = 405). Bars show the percentage distribution across five Likert response categories for each statement.

Table 3. Association between food safety awareness variables and respondents' risk perception scores (N = 405)

Awareness variable	Group	n	Mean rank	Test statistic	p-value	Effect size
Improperly processed products can transmit disease	No	27	181.33	U = 4518.0	0.317	r = 0.050
	Yes	378	204.55			
Heard of zoonotic diseases	No	93	172.03	U = 11628.0	0.004	r = 0.145
	Yes	312	212.23			
Aware of tyre/plastic use during singeing	No	132	174.02	U = 14193.0	0.001	r = 0.173
	Yes	273	217.01			
Belief improperly processed *ponmo* poses health risk	No	33	188.68	$\chi^2 = 11.703$	0.003	$\varepsilon^2 = 0.024$
	Yes	342	210.25			
	Not sure	30	136.10			
Belief tyre/plastic burning harms health	No	18	132.75	$\chi^2 = 9.173$	0.010	$\varepsilon^2 = 0.018$
	Yes	366	208.43			
	Not sure	21	168.50			
Aware chemical residues may remain	No	18	177.00	$\chi^2 = 36.877$	<0.001	$\varepsilon^2 = 0.087$
	Yes	333	218.51			
	Not sure	54	116.00			

4. Discussion

This study provides new insights into food safety awareness, food safety risk perception, and participants' attitudes to food safety traceability in a 'One Health' perspective in an online sample of Nigerians.

While mostly the microbiological and chemical hazards of *ponmo* have been previously investigated, little research has been conducted on consumers' perception of these hazards. The findings of the present study show that the overall awareness of specific hazards of *ponmo* is satisfactory, with increased awareness relating to specific hazards being associated with increased perception of food safety risk (16).

The overall level of awareness among the respondents is indeed encouraging as the evidence of food safety hazards caused by *ponmo* is rising. More than 90% were aware that there could be transmission of diseases from improperly processed animal products, and 84.4% were aware that improperly processed *ponmo* could be a health risk. These results are in line with the general consumer awareness that food safety is a concern in the production of meat and meat products. In a multi-country survey, 2,723 consumers from nine countries reported that among the food categories perceived as posing the highest risk to consumers' health, meat and meat products are the first category (17). It is worth adding that the level of awareness that was observed in the present study is also relatively high as compared

with previous Nigerian studies. A survey of 869 meat consumers in Ilorin revealed that 46.4% of the respondents were knowledgeable about food safety; however, their educational level was found to be correlated with their food safety knowledge (11). This could therefore be attributed to differences in education and recruitment factors, at least in part, and be a reflection of the increased awareness recorded in the present study. Furthermore, the microbiological investigations in recent years have also revealed that almost all samples of ready-to-eat *ponmo* were found to be contaminated with foodborne pathogens such as *Staphylococcus aureus*, *Escherichia coli*, *Proteus* spp., and other opportunistic bacteria (7). Similarly, *S. aureus* with a number of enterotoxigenic genes was found in a ready-to-eat *ponmo* product offered in Lagos (8); high microbial counts and multiple drug resistance were also reported in *ponmo* products sold in the southwest of Nigeria (1). These findings suggest that relatively high consumer awareness noted in the current study is with respect to hazards with a demonstrated microbiological basis.

The findings can also be considered in relation to broader evidence on food safety knowledge among Nigerian consumers. In this study, the awareness levels were overall higher than in previous studies carried out on consumers in Nigeria. Although consumers' attitudes towards food safety in the Ilorin study were high, significant gaps in their food safety knowledge were reported. The respondents in the present study, however, had high awareness of most of the food safety-related questions (11). This difference should, however, be noted in the context of the general food safety literature in Nigeria. In a systematic review of 87 studies on food safety perspectives and practices of consumers and vendors in Nigeria, the generally high food safety knowledge was considered better than observed food safety practices, and a significant proportion of the studies focused on specific regions and urban areas (18). The high education level of the present sample (99.3% tertiary or postgraduate) may partly explain this difference; however, differences in the population of the sample and the way in which they were recruited may also account for this difference. This association between education and food safety knowledge has also been reported among Nigerian meat consumers, with those with higher levels of education more knowledgeable (11). Access to food safety information is likely to be even more prevalent among the high education levels and may also limit the extent to which the findings can be extrapolated to consumers with lower education levels or limited access to electronic communications. Importantly, awareness about the use of tyres, plastic, and other waste materials in singeing (67.4%) was significantly less than awareness on harmful effects on health (90.4%). Similar differences between food safety and risk perception along various dimensions have also been reported for consumers in other countries. In a national survey in China, consumers' perception of hazard severity was greater than their perception of susceptibility, meaning that awareness of hazard severity is not necessarily followed by awareness of exposure to the hazard (19). This discrepancy in the current study could possibly be a sign that a lot of consumers are aware that unsafe food handling practices could lead to health problems; however, they are not as familiar with the specific practices

responsible for food contamination. Delivering such processing information to the consumer may therefore help them make better purchasing choices.

An important observation of this research is that being aware of specific hazards was strongly associated with perceived risk. Awareness of chemical residues after poor processing showed the largest Kruskal–Wallis effect size among the three-category awareness variables, while awareness of tyre/plastic use during singeing showed a significant association among the two-category awareness variables. This is in line with broader evidence that knowledge is an influencing factor on food safety risk perception. A meta-analysis of 128 empirical studies found that along with other factors, the key drivers of food safety risk perception were knowledge, trust, and sociodemographic factors (20). Furthermore, the relationship between nutrition knowledge and concern about related food hazards was reported by Siegrist et al (21) to be positive, such that higher nutrition knowledge was linked to greater concern about the specific food hazards. Findings from a national survey of Chinese consumers also revealed important relationships between food safety knowledge and risk perception; however, the strength of these relationships differed by level of perceived risk (19). The results were similar to previous studies indicating that behaviour-specific risk perception plays a role in the association between food safety knowledge and protective food-handling practices (13). However, this present study examined risk perception and not food-handling practices, thus indicating that the risk perceptions of the respondents may be associated more with their awareness of tangible, identifiable hazards and their pathways, rather than with general food safety awareness.

The observed relationship is also supported by evidence of chemical hazards related to *ponmo*. The results of the studies carried out in Nigeria and Ghana were similar to the observation that the hide-processing method of singeing with tyres releases much higher levels of toxic metals and polycyclic aromatic hydrocarbons (PAHs) than other, more appropriate hide processing methods (3, 5). Higher concentrations of lead, chromium, mercury and arsenic were found in tyre-processed cowhide than in firewood- or LPG-processed cowhide (3), and higher concentrations of PAHs and estimated lifetime cancer risk were found in tyre-singed products than in firewood- or LPG-processed products (6). In addition, recent studies in Nigeria have also shown that the concentrations of heavy metals found in commercially purchased *ponmo* are above their safety limit (4) and that animals exposed to high concentrations of heavy metals in *ponmo* experienced liver damage after long-term consumption (16). These results provide a basis for concerns around chemical contamination of *ponmo* and could account for the strong association between awareness of chemical hazards and perceived risk in the present research.

The respondents who answered “Not sure” to awareness questions had a specific pattern of risk perception. These respondents answered all the variables with 3 answer categories in a consistent manner, with the lowest risk perception scores and not with intermediate ones between “Yes” and “No”. Previous consumer studies have indicated that in food safety, knowledge and risk perception were related but distinct constructs; differences in knowledge and

perception of susceptibility and severity have been found to impact consumers' assessment of food-safety risks (19, 20). This could suggest that if respondents are unsure of a particular food safety concern, there is a lower perception of risk associated with that concern; however, the cross-sectional study design does not explain why respondents chose "Not sure". Nevertheless, people who are not familiar with some processing hazards might be an important target group for education on food safety, as greater access to food safety information about a particular hazard may help to build their food safety knowledge.

However, awareness of the potential for animal products to be a source of infectious disease when they are not processed properly was not particularly associated with overall risk perception. This result indicates that, at least in this sample, one's basic understanding of foodborne disease might not be enough to differentiate the differences in the perceived risk that consumers feel with the use of *ponmo*. While there is evidence of associations between food-safety knowledge and risk perception in previous studies (18, 19), recent studies indicate that risk perception could be especially relevant to specific food-safety behaviours and hazards. However, Ishra et al (13) found that behaviour-specific risk perception was part of the factors linking food-safety knowledge and food-safety practices among adult consumers. Similarly, studies on perceived food risks have indicated that consumers' risk evaluations can be affected by their knowledge of specific food-related risks (21). Rather, specific hazards observed in the present study show more significant associations with consumers' risk perceptions, which would seem to be more related to the more tangible hazard pathways associated with the product itself, such as singeing with tyres or contamination by chemicals.

These findings have important implications for food safety communication. The difference has implications for public health messages and suggests that campaigns emphasizing particular processing hazards could be used in conjunction with messages that focus on general food safety. The results also corroborate the One Health concept as an applicable concept to the safety of *ponmo*. Unsafe processing practices can lead to impacts on environmental, animal, and human health. Tyres and plastic wastes can be a source of pollution and contamination of the environment and food products, while inadequate hygiene in food production and food handling can lead to food products and potentially zoonotic microorganisms being contaminated. This is a reflection of the overall concept of One Health, where food safety threats can arise at the intersection of human, animal, and environmental health (9). A lack of zoonotic risk awareness does not also mean elimination of risky food practices, as evidenced by consumer research (22). The low awareness levels reported by the respondents are similar to the findings of a recent study (10) which revealed the gaps in knowledge of zoonotic diseases among frontline health professionals in Nigeria, particularly environmental health. Thus, better One Health literacy from professional to consumer levels may help to improve overall food safety preparedness along the food chain.

In addition to consumer awareness and One Health considerations, traceability, as another key aspect of food safety governance, was also investigated in this

study. The attitudes of the respondents were generally positive towards traceability; however, there were some differences in the responses to the various traceability-related items. This observation aligns with the fact that there is evidence of consumers appreciating traceable food. Studies indicated that consumers are willing to pay premium prices for food with a traceable origin, with a strong valuation for traceable meat, and that higher willingness to pay was observed in developing countries (15). A systematic review conducted recently also found dimensions of consumer perspectives on food traceability, such as food safety, quality assurance, transparency and consumer trust (23). The range found in the present study for the various traceability-related items could thus suggest a differential value among the consumers for traceability information; however, this value may be higher on those items that enable the consumers to assess a food's health risks, production methods, and reliability. The magnitude of concern about chemical contamination noted in the current study would indicate that traceability systems that are able to distinguish processing methods or certified processing facilities may be a way to reinforce consumer trust and facilitate safe practices along the supply chain.

The implications of these findings extend beyond consumer education alone. The results are not only relevant for consumer education. Although the majority of respondents understood the health implications of tyres and plastics burning, the study did not examine any of this, or even the views of processors. Thus, consumer education should be supported by effective enforcement of regulations, discouragement of waste from being singed, and substitution with safer products. Such measures would address the processing practices that contribute to the identified food safety concerns rather than relying on consumer awareness alone. Limitations of the study include its convenience sampling of internet users, the fact that it was a highly educated and young population, cross-sectional design, and small subgroup sizes. Thus, findings should not be considered representative or causal. However, the study offers some early insights that can be employed to inform strategic food safety information and future nationally representative and qualitative studies to further investigate food safety awareness, risk perception, and traceability attitudes related to *ponmo*.

5. Conclusion

The results of this study provide evidence that the food safety risk knowledge of the participants in this online Nigerian sample was very high with respect to food safety problems associated with unsafe processing of *ponmo* and chemical contamination. Specific hazards were significantly associated with perceived food safety risk, whereas general awareness of disease transmission was not significantly associated with risk perception. Greater uncertainty regarding processing risk was correlated with less perceived risk. The results of this study provide a health policy rationale for an integrated One Health approach that incorporates consumer risk communication, regulatory enforcement, safer processing practices, and effective traceability through the food chain. These measures are in line with the policy principles of food safety, which call for the prevention of foodborne illness, a risk-based approach to food safety control, and collaboration among human, animal, and environmental health.

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Authorship contributions

OOA: Conceptualisation, investigation, statistical analysis and writing

JJO: Investigation, formal analysis, review and editing.

TDA: Investigation, designing of survey questions and data curation.

TVA: Visualisation, validation, review and editing.

Declaration of competing interest

The authors affirm they have no conflicts of interest to disclose.

Data availability

Data will be available on demand.

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