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Sensory Evaluation and Consumer Acceptability of an African Fish Based Flavouring Agent and Taste Enhancer

KEYWORDS: Flavouring agent, taste enhancer, Lanhouin, fermented fish, sensory profile, consumer preference, acceptance

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ABSTRACT *The sensory profile and consumer acceptance of a traditional flavouring agent and taste enhancer (FATE) locally referred to as Lanhouin, which is a salted fermented fish product made from two types of fish (king fish and cassava fish) through three different fermentation processes (aerobic, semi-aerobic and anaerobic conditions) were explored. The sensory testing was performed by 17 semi-trained panellists, and the acceptability of FATE was tested by consumers (n=200) in Cotonou and Abomey-Calavi municipalities. Traditional FATE were sensorially different, with king fish FATE having the strongest odour (ammoniacal odour) and cassava fish FATE being whitish in colour. Three classes of consumer behaviour were identified; primarily those who liked all the FATE samples (35% of consumers); those disliking FATE made from anaerobically fermented king fish (37%); and those disliking FATE made from aerobically fermented cassava fish (28%). Consumer acceptance was significantly associated with fish size, whitish colour, dried fish odour and ammoniacal odour. In terms of consumer preference, FATE made from semi-aerobically fermented king fish and FATE made from cassava fish (except for aerobic fermentation) were the most preferred and would be the most suited for further product development suited to markets in West Africa and export to the EU. The similarity in taste attributes for cassava fish and king fish when used for cooked rice dishes will be helpful in designing the form in which FATE can be marketed for wide acceptance.*

INTRODUCTION

Lanhouin is a traditional flavouring agent and taste enhancer (FATE) made from salted and fermented fish commonly made from cassava fish (*Pseudotolithus senegalensis*) and King fish/ Spanish mackerel (*Scomberomorus tritor*) mainly produced in the coastal regions of West Africa.[1] It is produced by natural and largely uncontrolled fermentation. For traditional Lanhouin production, the fresh fish is scaled, gutted, washed, followed by a ripening period when biochemical and microbiological activities lead to partial deterioration of the fish. The product obtained after ripening is treated with salt and allowed to ferment for 3 to 9 days [2,3] . Lanhouin is mostly used as a taste enhancer and flavouring agent in many types of dishes in West African countries. Previous works identified the various processing technologies of Lanhouin[2,3]. Thus variations in sensory profile, primarily quality attributes such as flavour and texture, are common, which may result in product rejection and then economic losses for the producer as well as missed opportunities to expand into new markets. Evaluation of sensory characteristics of Lanhouin is a challenge for reducing the gap in quality variation and developing relationships between consumer acceptance and sensory characteristics. Product quality upgrading for African markets should be based on the assessment of consumer acceptance, which is seen as an important step in marketing strategies. This study primarily explored the sensory profile and the consumer acceptance of Lanhouin. Secondly, it is important to establish the relationships between the sensory attributes, consumer acceptance and socio-economic status, in order to understand the factors that influence acceptability of Lanhouin in order to develop the potential of this project as a flavouring agent and taste enhancer for local markets and potential export

MATERIALS AND METHODS

Experimental samples

Two types of fish named cassava fish (*Pseudotolithus senegalensis*) and King fish/Spanish mackerel (*Scomberomorus tritor*), which are commonly used for Lanhouin production in Benin, were bought at Agoué beach in Grand Popo municipality. The two types of fish were processed into Lanhouin by two highly skilled processors using the three different fermentation technologies previously described.[2] When the Lanhouin samples were processed using the two first variants (fermentation in aerobic conditions and semi-aerobic conditions), the fresh fish was scaled, gutted, put in a container, covered with clean clothes and left at ambient temperature for ripening for 11-16 h. The ripened fish was washed again and put in a basket to drain; dry salt was then rubbed into the gills, the belly cavity, on the surface, and then the ripened

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and salted fish was allowed to ferment in the basket (as it was aerobic conditions), or in the basket with a cement layer (semi-aerobic conditions) for 9 days before being sun-dried for 1 day. With the third variant (fermentation in anaerobic conditions) the fresh fish was not ripened before being fermented for 9 days in a 2-metre deep hole to exclude air. Three types of Lanhouin per type of fish were obtained, according to the fermentation technology described below:

- Fermentation in aerobic conditions in basket (FA)
- Fermentation in semi-aerobic conditions in basket with cement layer (FSA)
- Fermentation in anaerobic conditions by burying fish in the ground without ripening (salted fish buried in a 2-metre deep hole) (FAN)

Ethical assessment and consent
This study was based on the panellists' written consent to participate. Beforehand, they were well informed about the objectives and methodologies of the study, and that their responses were anonymous and their participation was entirely voluntary, with the option of withdrawing at any point during the study.

Sensory evaluation
Samples were scored for descriptive terms by the sensory panel and for acceptability by ordinary consumers.

Lanhouin sample preparation for sensory evaluation
Two types of products were submitted to sensory testing: Lanhouin (raw) and cooked rice containing Lanhouin. Panellists evaluated whole Lanhouin samples because this is the form that Lanhouin comes in when consumers make a purchasing decision at the market. For consumption purposes, Lanhouin samples of king fish/Spanish mackerel (K) and cassava fish (C) obtained from tested processing technologies were integrated into a rice dish, as per local culinary practice: rice (400 g) was washed in tap water (400 mL) and drained of water for five minutes. The Lanhouin sample (40 g) and rice were cooked together with 1000 mL tap water without salt on an electric stove set at 250 °C for 30 min. The cooked rice containing Lanhouin was kept in a heated box (55 ± 2°C) for up to one hour before serving.

Sensory testing
Lanhouin samples and cooked rice containing Lanhouin were scored by a semi-trained sensory panel of 17 people, using a modified version of quantitative descriptive analysis (QDA) since standards were not provided.[4] Testing was carried out in an air-conditioned room with controlled lighting. The sensory testing was conducted at the Faculty of Agronomic Sciences, University of Abomey-Calavi (Benin), where an individual panel booth area was set up for each panellist to avoid interaction. The language used for sensory testing was French. The panellists had been screened for familiarity with product and ability to determine differences between Lanhouin samples, and then cooked rice containing Lanhouin samples. The panel generated 11 sensory attributes for all the Lanhouin samples and the cooked rice containing Lanhouin samples, during a preliminary focus group session guided by the investigator. Sensory attributes generated from group consensual discussion were as follows (we have included the English language translations):

- Whitish colour (from ash to dirty whitish) – Lanhouin that had ash colour or dirty whitish colour
- Softness (from soft to hard texture) – ease of pressing the raw Lanhouin with one finger
- Dry (from moist to dry) – Lanhouin with a moist or dry feel
- Size (from small to large) – small or large Lanhouin
- Dried fish odour (from weak to strong)- Lanhouin characterised by a dried fish aroma
- Ammoniacal odour (from weak to strong) – Lanhouin giving off an ammoniacal odour
- Salty taste (from less salty to very salty) – salt content in the cooked rice containing Lanhouin
- Fish taste (from fresh to dried) – fish taste in the cooked rice containing Lanhouin
- Smoked shrimp taste (from weak to strong) – smoked shrimp content in the cooked rice containing Lanhouin.
- Shrimp odour (from fresh to smoked) - cooked rice containing the Lanhouin that smelled of fresh or smoked shrimp
- Fish odour (from fresh to dry) - cooked rice containing the Lanhouin that smelled of fresh or dried fish.

The sensory testing was conducted on the six Lanhouin samples and the six rice containing Lanhouin samples using these sensory attributes. In each session, three Lanhouin samples (coded with a three-figure random number) were first served on a meal tray, and then cooked rice containing Lanhouin samples were served on a whitish paper plate. The order in which they were presented was randomized for the panellists. As far as cooked rice containing Lanhouin is concerned, panellists were offered mineral water to rinse their mouths between tasting. The intensity of each descriptor was scored on a 100 mm unstructured scale.

Consumer acceptability
Two hundred (200) consumers were interviewed at seven locations at Cotonou and Abomey Calavi, using the method of central location testing.[5] These were as follows: Akassato (n= 55); University of Abomey-Calavi (n=43); Abomey-Calavi town (n= 12); Loading dock of Abomey-Calavi (n= 44); Artisanal fishing port of Cotonou (n= 24) Agla Beach (n= 15); Placodji (n=7). All consumers were African. Consumers were presented with three whole Lanhouin (raw) samples in random order. They were asked to score the acceptability of Lanhouin samples on the basis of the colour and the odour using a 9-point verbal hedonic box scale which varied from 'extremely dislike' to 'extremely like' [5,6]. After testing Lanhouin samples, consumers were interviewed to obtain demographic information regarding age, education, gender, occupation, Lanhouin fish type bought, form of Lanhouin bought, consumption of dishes containing Lanhouin, how often dishes containing Lanhouin were eaten, where dishes containing Lanhouin were eaten and preferred dishes containing Lanhouin. The interview took approximately 20 mins.

Statistical analysis
The collected data were recorded using Sphinx survey plus2 (version 4.5) software. Analysis of variance (ANOVA) or Kruskal-Wallis as appropriate, correlations, principal component analysis (PCA), cluster analysis (agglomerative hierarchical cluster; Ward's method) and internal preference mapping were computed using XLSTAT (version 2011, Addinsoft, Paris, France) and STATISTICA (version 6, StatSoft France, 2004).

RESULTS AND DISCUSSION

Sensory profile of Lanhouin samples and cooked rice containing Lanhouin
The effect of raw Lanhouin samples were significantly different ($P<0.05$) with respect to the sensory attributes of whitish colour, hard texture, dried appearance, size, dried fish odour, ammoniacal odour and salty taste (Table 1). This range of sensory attributes was higher than that reported by Anihouvi et al.[7], who pointed out that the acceptance of Lanhouin by consumers was determined by aroma and texture. No significant difference was evidenced for shrimp odour, fishy taste or smoked shrimp taste with respect to cooked rice containing Lanhouin. This indicated that the intensity of sensory attributes differs among Lanhouin samples, but not for cooked rice containing Lanhouin. There were no significant differences among the panellists for whitish colour and size, though a significant difference ($p < 0.05$) was observed among the panellists for all other sensory attributes (Table 1). In addition, significant interactions between Lanhouin type and the panellists for attributes of whitish colour, dried appearance, dried fish odour and fishy taste were observed. These interactions for some of the attributes are probably due to the fact that

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it was not possible to provide standards and some attributes were more difficult to evaluate. However, no significant interaction was observed between Lanhouin and the panellists for hard texture, size, ammoniacal odour, shrimp odour, salty taste and smoked shrimp taste.

PCA of sensory attributes resulted in a two-factor solution accounting for 87.92% of the total variation, of which 72.21% was explained by the first principal component (PC) and 15.71% by the second (Figure 1). The sensory attributes were largely separated in the direction of PC1, which encompassed whitish colour, hard texture, dried appearance, size, fishy odour, ammoniacal odour, shrimp odour and fishy taste. In the direction of PC2 the attributes ranged from salty taste to smoked shrimp taste.

Table 1. Probability values for effects of differences due to Lanhouin samples, panellists and their interaction with sensory attributes

Sensory attributes	Probability		
	Samples	Panellists	Interaction
Whitish colour	0.00*	0.56	0.00*
Hard texture	0.04*	0.00*	0.10
Dry	0.00*	0.00*	0.00*
Size	0.00*	0.49	0.99
Dried fish odour	0.00*	0.00*	0.00*
Ammoniacal odour	0.00*	0.00*	0.62
Shrimp odour	0.75	0.00*	0.10
Salty taste	0.00*	0.00*	0.86
Fishy taste	0.14	0.00*	0.00*
Smoked shrimp taste	0.15	0.00*	0.85

*Significantly different at P < 0.05

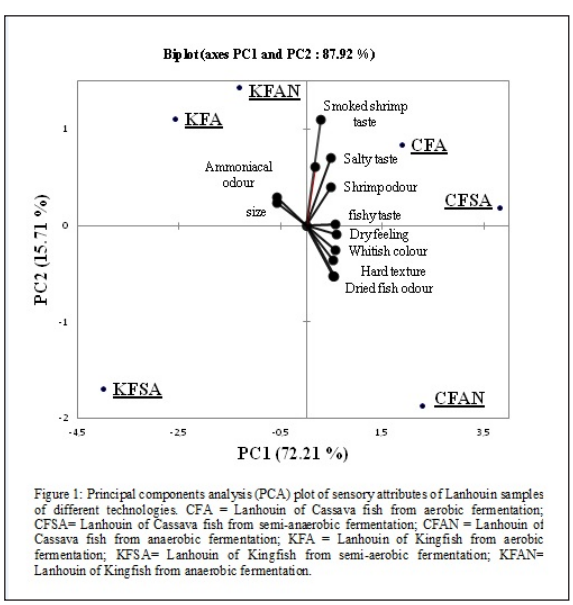

Figure 1: Principal components analysis (PCA) plot of sensory attributes of Lanhouin samples of different technologies. CFA = Lanhouin of Cassava fish from aerobic fermentation; CFSA= Lanhouin of Cassava fish from semi-anaerobic fermentation; CFAN = Lanhouin of Cassava fish from anaerobic fermentation; KFA = Lanhouin of Kingfish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

The samples obtained with king fish/Spanish mackerel (*Scomberomorus tritor*) (KFA, KFSA, KFAN) were located in the left-hand quadrant and had the lowest score for the majority of sensory attributes, apart from ammoniacal odour and size. In the right-hand quadrant, the samples obtained with cassava fish (*Pseudotolithus senegalensis*) (CFA, CFSA, CFAN) had the lowest score of ammoniacal odour and size. Lanhouin samples of this type of fish were associated with high scores of dried fish odour, shrimp odour, fishy odour, whitish colour, texture, dried appearance, salty taste, fishy taste, and smoked shrimp taste; as Lanhouin players in a previous work attributed a soft texture, firm and spongy, and a strong but not repugnant odour to a good Lanhouin.[2] It was revealed that cassava fish Lanhouin was better known than that of kingfish.

Cluster analysis (agglomerative hierarchical cluster analysis, Ward's method, Euclidean distance) of Lanhouin samples with respect to the technology indicated that Lanhouin samples were clustered into three different groups according to similarity of sensory attributes, as illustrated in the dendrogram (Figure 2.). Cluster 1 comprised Lanhouin made from anaerobically fermented king fish (KFAN, 16.7%), and seemed different from other types of Lanhouin. Cluster 2 comprised two types of Lanhouin made from semi-aerobically fermented and aerobically fermented king fish (KFSA+KFA, 33.3%), which indicates that both fermentation technologies gave similar sensory properties for king fish Lanhouin. Cluster 3 comprised all Lanhouin samples from cassava fish, whatever the technology used (CFAN+CFSA+CFA, 50.0%). For consumer testing, one sample of each cluster was chosen as representative: KFAN for cluster 1, KFSA for cluster 2 and CFA for cluster 3.

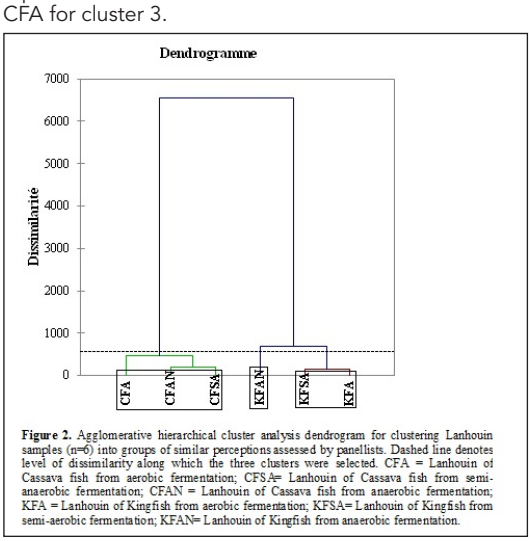

Figure 2. Agglomerative hierarchical cluster analysis dendrogram for clustering Lanhouin samples (n=6) into groups of similar perceptions assessed by panellists. Dashed line denotes level of dissimilarity along which the three clusters were selected. CFA = Lanhouin of Cassava fish from aerobic fermentation; CFSA= Lanhouin of Cassava fish from semi-anaerobic fermentation; CFAN = Lanhouin of Cassava fish from anaerobic fermentation; KFA = Lanhouin of Kingfish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

Consumer acceptability of Lanhouin samples

The mean acceptability of Lanhouin samples differed significantly ($p < 0.05$) with respect to technology; the Lanhouin made from anaerobically fermented kingfish gave the lowest acceptance value (Table 2). In general, consumers gave an average acceptable score to all Lanhouin samples, since the mean scores were above 5 i.e. the acceptance threshold

Table 2: Consumer acceptability of Lanhouin

Lanhouin samples	Mean ± standard error
KFSA	6.5±0.11b
KFAN	5.9±0.11a
CFA	6.2±0.14b

Letters a to b indicate significant differences ($p< 0.05$) between the samples

CFA = Lanhouin made from aerobically fermented cassava fish; KFSA= Lanhouin made from semi- aerobically fermented king fish; KFAN= Lanhouin made from anaerobically fermented king fish

Segmentation of consumers into groups of similar acceptance patterns regarding Lanhouin samples

Hierarchical cluster analysis (Ward's method) indicated that consumers were clustered into three different segments as illustrated in the dendogram (Figure 3). Segmentation gives

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a more complex variation in acceptability among consumers, and is helpful for understanding differences in consumer behaviour.

The three segments did not significantly differ ($p > 0.05$) in terms of sociological criteria such as age, gender, marital status, education level or occupation (Table 3). There was no significant difference ($p > 0.05$) in the form of dishes containing Lanhouin being consumed where it was used as a FATE or the frequency of eating dishes containing Lanhouin. Conversely, the type of Lanhouin (cassava fish Lanhouin, king fish Lanhouin and lesser African threadfin Lanhouin) usually consumed differed significantly between the clusters ($p < 0.05$; Chi Square Test). This indicates that the consumers interviewed clearly distinguished the different types of Lanhouin fish.

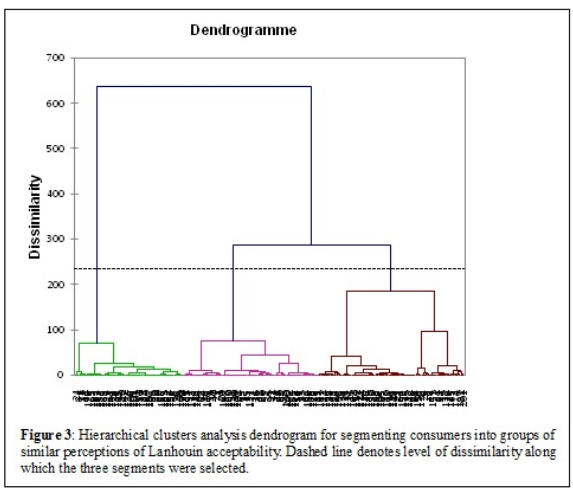

Figure 3: Hierarchical clusters analysis dendrogram for segmenting consumers into groups of similar perceptions of Lanhouin acceptability. Dashed line denotes level of dissimilarity along which the three segments were selected.

Table 3: Demographic differences and consumer attitudes to Lanhouin (buying and consumption) with respect to cluster division

Question	Cluster 1 «all type likers»	Cluster 2 «CFA & KFSA likers»	Cluster 3 «KFSA &KFAN likers»	Probability Chi Square test ($p<0.05$)
Number of consumers	69	75	56	
Age (%)				0.323
[18-35]	40	35	25	
[36-45]	27	40	33	
[46-55]	33	39	28	
[56-65]	33	67	0	
[66 +]	80	0	20	
Gender (%)				
Male	40	31	29	0.559
Female	33	39	28	
Marital status (%)				
Single	38	40	23	0.622
Married	35	36	28	
other	9	45	45	
Education level (%)				
No formal education	33	43	24	0.845
Primary school	32	32	37	
Secondary school	38	34	28	
University	36	38	26	
Occupation (%)				
Civil service	29	43	29	0.844
Housewife	27	50	23	
Self-employed	32	32	36	
Unemployed	50	50	0	
Development worker (representative, advisor, etc.)	0	50	50	
Student	38	40	23	
Trader	41	32	27	
Type of Lanhouin usually consumed (%)				
Cassava fish Lanhouin	37	43	20	0.003*
King fish Lanhouin	29	22	48	
Lesser African threadfin Lanhouin	50	50	0	
Form of Lanhouin (%)				
Whole Lanhouin	29	46	26	0.088
Piece of Lanhouin	42	28	30	
Dishes containing Lanhouin mostly consumed				
Vegetable sauce (sticky, leaves)	32	39	29	0.374
Cooked tomato sauce	20	20	60	
Uncooked tomato sauce	71	14	14	
Rice	50	25	25	
Groundnut sauce	60	20	20	
Palm nut sauce (decoussounou)	50	50	0	
Frequency of eating dishes containing Lanhouin (%)				
Everyday	64	9	27	0.093
Several times a week	34	38	28	
Once a week	34	32	34	
Once a month	23	46	31	
Rarely	22	78	0	

***Significantly different at P < 0.05**

The consumer segments (clusters) differed significantly in acceptability ($p < 0.05$; Turkey HSD test) for Lanhouin samples (Figure 4). The largest consumer cluster 2 comprised 37% of consumers who like all types of Lanhouin, except Lanhouin KFAN (Lanhouin KFAN dislikers); this was followed by cluster 1 "Lanhouin likers" (35%) who consume all kinds of Lanhouin, and cluster 3 comprising 28 % of consumers who also like all types of Lanhouin, except Lanhouin CFA (Lanhouin CFA dislikers). Those in cluster 1 gave high acceptability scores to all types of Lanhouin samples, with Lanhouin made from aerobically fermented cassava fish (CFA: 7.5 ± 0.1) followed by Lanhouin made from anaerobically fermented king fish (KFAN: 7.0±0.1) and Lanhouin made from semi-aerobically fermented king fish (KFSA: 6.9 ± 0.2). Consumers in cluster 2 gave the highest score for Lanhouin made from aerobically fermented cassava fish (CFA: 7.0 ± 0.1), and the lowest for Lanhouin made from semi-aerobically fermented kingfish (KFSA: 5.6 ± 0.2). Consumers in cluster 3 scored highest Lanhouin made from semi-aerobically fermented king fish (KFSA: 7.2 ± 0.2), and lowest the Lanhouin made from anaerobically fermented king fish (KFAN: 6.2 ± 0.2).

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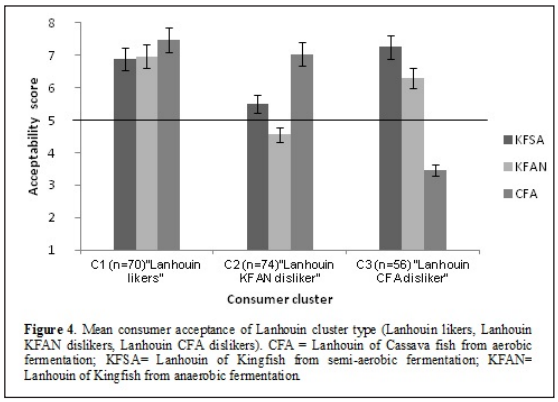

Figure 4. Mean consumer acceptance of Lanhouin cluster type (Lanhouin likers, Lanhouin KFAN dislikers, Lanhouin CFA dislikers). CFA = Lanhouin of Cassava fish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation.

Correlations between sensory attributes and consumer acceptance

Regarding correlations between consumer acceptance and the sensory attributes, linear models relating consumer liking and sensory score were explored for the Lanhouin samples as reported for parboiled rice in West Africa [6] (Figure 5). For the whole consumer group, no significant correlation between mean acceptance score and sensory attributes was observed. However, significant positive correlations were observed between "Lanhouin CFA dislikers" acceptance and size & ammoniacal odour. These correlations showed that "Lanhouin CFA dislikers" were more discerning with these sensory attributes. Also, significant negative correlations were identified between "Lanhouin CFA dislikers" and whitish colour & dried fish odour. These correlations show that "Lanhouin CFA dislikers" clearly distinguished, and knew that king fish Lanhouin cannot be whitish in colour but ashy colour, and that its odour is very different from that of dried fish, whatever the technology used.

Through this study, it appeared that the main quality attributes of Lanhouin were the colour, the texture, the odour and the taste. This study has also demonstrated that within each population, different segments of consumers existed with different preferences. Similar findings were reported for Adjuevan and other fish products [8, 9]. A previous study related to Adjuevan (a Lanhouin like-product) consumer's characteristics has revealed that the reason for Adjuevan usage by the consumers is its flavour and taste, and the usage pattern change according to consumer's acceptance[10].

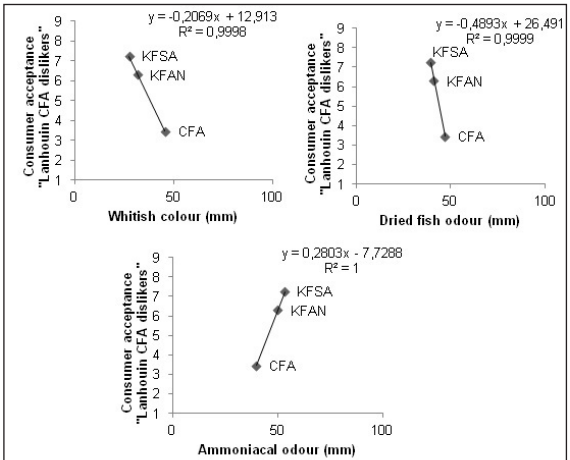

Figure 5. Correlations between sensory attributes and consumer acceptance of Lanhouin. CFA = Lanhouin of Cassava fish from aerobic fermentation; KFSA= Lanhouin of Kingfish from semi-aerobic fermentation; KFAN= Lanhouin of Kingfish from anaerobic fermentation. Significantly different at $P < 0.05$.

CONCLUSION

The study showed distinct descriptor profiles for all Lanhouin samples tested. The sensory descriptors for cassava fish Lanhouin made using the three technologies are the same, while for king fish Lanhouin made using aerobic and semi-aerobic fermentation differed widely from king fish Lanhouin obtained by anaerobic fermentation. Consumers gave an acceptable score for the various Lanhouin samples presented. However, three consumer clusters were distinguished: the largest consumer cluster 2 "Lanhouin KFAN dislikers" comprised 37% of consumers, followed by cluster 1 "Lanhouin likers" (35%) and cluster 3 "Lanhouin CFA dislikers" (28%). The consumer cluster "Lanhouin CFA dislikers" was positively correlated ($p < 0.05$) with size and ammoniacal odour, and negatively correlated with whitish colour and dried fish odour. From cluster analysis it appeared that semi-aerobically fermented king fish Lanhouin and cassava fish Lanhouin (except for aerobic fermentation) are more frequently consumed because of their convenience. Consequently, these two types of Lanhouin will undergo product development to improve the safety, consistency and acceptability for both local markets in West Africa and export to EU markets for use as a flavouring agent and taste enhancer.

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