

SENSORY STUDIES WITH LOW-INCOME, FOOD-INSECURE CONSUMERS

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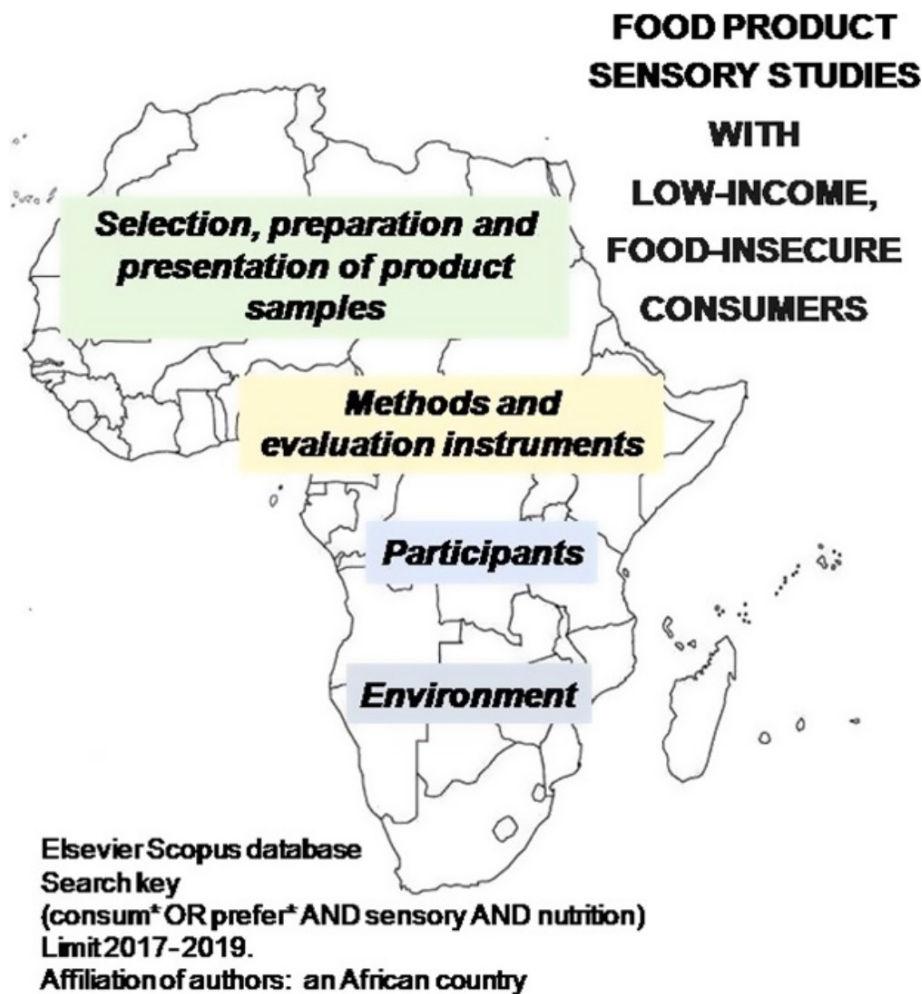
HIGHLIGHTS

- Economically vulnerable consumers are conscious of food sensory quality.
- Development and validation of sensory test methods for use with low socioeconomic consumers are needed
- The food choice motives of consumers in African countries need to be better understood.
- Researchers in African countries need to adapt best practice principles to apply under local circumstances.

ABSTRACT

A substantial proportion of African population is food-insecure, of low socioeconomic background. While much effort is made to address cost, safety and nutritional quality of food for economically-vulnerable consumers, research specifically focusing on food acceptance and preference is seriously lacking. Here we present examples of recently published studies to demonstrate the value of food research involving African consumer testing. A systematic search of the literature was performed and 44 studies reviewed. Gaps in research on the topics and approaches used by researchers when conducting consumer tests with these consumers were identified. The review concludes with a discussion about modifications of test methodologies that may be required when conducting consumer tests with low-income, food-insecure consumers. The consumer studies with undernourished or vulnerable individuals have clearly demonstrated the importance of doing such studies to formulate foods adapted for these target markets. These studies are important to fight undernutrition.

GRAPHICAL ABSTRACT



Introduction

Worldwide more than 820 million people suffer from hunger and do not have access to enough food to sustain their daily requirements for nutrients [1]. A substantial proportion of this vulnerable group is found in developing countries in Africa where the majority of the population live in poverty. In such a food-insecure environment, there is not physical and economic access, at all times, to sufficient amounts of nutritious, safe and culturally appropriate and preferred food to live a healthy and active life [1].

While much effort is made to address the cost, safety and nutritional quality of food for economically-vulnerable consumers, research specifically focusing on the acceptance and preference of the sensory properties of food solutions is seriously lacking. A widely held belief is that economically-deprived consumers are not concerned with food quality especially sensory quality, and will accept whatever is on offer as long as it is affordable and alleviate hunger. While it is reasonable to assume that socioeconomic restrictions will override food preferences in survival situations, impoverished consumers are essentially very quality conscious [2;3], as they cannot afford to replace product purchases or selection failures and apply a much larger percentage of disposable income to food compared to richer consumers [4]. Moreover, the sensory quality of food contributes much to the emotional wellbeing of consumers [5] and drives acceptability more than nutritional quality [1,2]. Whether foods are produced and consumed in affluent or poor environments, it has been known for a long time

that sensory and consumer science can contribute to a better understanding of the reasons for food acceptance or rejection [6]. Making sure that food products are culturally appropriate, acceptable and preferred is an important role of sensory and consumer scientists. Food choice motives of consumers in different countries and at different socioeconomic levels vary substantially [7]. Consumer studies provide insights for the development of acceptable and preferred food products to market, distribute and consume. Sensory quality of product options is also important for agri-food processors in order to offer the most promising products to meet the expectations of consumers [6].

Test methods to determine acceptance and preference of food and beverage products are well established and are also evolving continually. This paper reviews research studies focusing on consumer acceptance of food products specifically aimed at the needs of food insecure, low-income populations in countries in Africa. The following questions form the objectives of the review:

1. What are the gaps in the current research on the topic (as per a review of a systematic selection of studies published between 2017 and 2019)?
2. What approaches did researchers use when conducting consumer tests with low-income, food-insecure consumers in African countries?
3. What (if any) modifications to test methodologies is required when conducting consumer tests with low-income, food-insecure consumers?

Methodology

A systematic search of literature published between 2017 and 2019 was conducted using Elsevier Scopus database and the search key (consum* OR prefer* AND sensory AND nutrition). The outputs were limited to reflect only studies by researchers reporting affiliation with an African country. A total of 57 outputs was manually screened for suitability for the review leading to a final count of 44 documents.

Recently published examples to demonstrate the value of consumer testing for food research aimed at consumers in African countries

The review of recent studies conducted in the African countries identified a number of benefits of consumer testing. The value was clearly demonstrated by Alowo et al. [8] in a study in Uganda that reported on the successful reduction of anti-nutrients and the improvement of protein digestibility and bioavailability of iron and zinc when applying traditional processing methods from a millet–sesame–soy composite complementary food formula. Despite the nutritional advantages achieved, the product's sensory acceptability declined as a result of the technological intervention. The insight obtained led to the conclusion that successful adoption of the technological treatment despite the efficacy of the improvement of the nutrient bioavailability will only be achieved if the low product sensorial appeal is also addressed.

In contrast, a study in Burkina Faso to determine the acceptability of six corn-soy blended flours and six lipid-based nutrient-enriched supplement foods showed that the supplements were well accepted by children and care-givers and these were therefore recommended for use to treat and prevent severe acute malnutrition (lipid-based nutrient supplements) and severe and moderate acute malnutrition (corn-soy blended flours) [9,10]. The addition of milk did not affect acceptability by young children [11]. It was concluded that supplementary foods would be well accepted by malnourished children served with or without milk [9].

Ramaroson Rakotosamimanana et al. [12], Zunghu et al. [13] and Dachana et al. [14] used sensory and consumer science to determine the optimal proportions of *Moringa oleifera* leaf powder (a highly nutritious food ingredient) where inclusion is limited by negative sensory

properties (bitterness, intense aftertaste, and fermented aroma) to include in snacks (mashed cassava, snacks, and cookies). Moringa leaf powder mixed with cassava root at 1.2% (w/w) in a sweet snack formulation was well accepted by school-aged children [15]. Contrary to these findings, another consumer study [16] informed that amaranth leaf powder as a provitamin A biofortificant added to extruded maize snacks did not give a positive level of acceptability even though the product has potential as a highly nutritious snack.

Other studies made an important contribution to consumer acceptance of lesser-known/less documented underutilized food crops and meal items e.g. cocoyam [17], stinging nettles [18], monkey orange [19], tiger nut beverage [20], Bambara groundnut [21] and grain amaranth [22].

An important study by Gama et al. [7], conducted in Malawi, provides important insights into factors that influence food choices in a low-income African country. Using a well-known Food Choice Questionnaire (FCQ) [23], it was determined that mood, health, price and preparation convenience, sensory appeal, and familiarity were the main factors influencing food choices of Malawian consumers. Consumer segments were identified and characterized based on the determined food choice motives and the consumers' demographic and socioeconomic data. Interestingly 77 % of respondents indicated that the satiation value ("filling") of food was very important to them. While the sensory appeal was not considered the most important food choice motive, as is the case in studies with consumers from high-income countries, food choices motives related to well-being (mood – factor items *Helps me to cope with life, Helps me relax, Cheers me, Makes me feel good*) were strong. This study confirmed the presence of differences in food choice drives among consumers due to demographic and socioeconomic factors.

On a different but interesting topic, it was described how consumers use sensory properties to judge the safety of food products. Häsler et al. [24] described the reliance by consumers in Tanzania on sensory attributes of milk to judge safety and quality in the absence of other systems of quality certification of products. In West Africa, many actors like farmers and produce sellers in low-income countries use physical indicators such as colour, neatness, presence of dirt and the odour of food products to assess the (lack of) cleanliness ("safety") of produce [25]. Gama et al. [7] emphasized consumers in Malawi's need for products that are certified and properly labeled as safety assurance indicators probably since sensory properties are not reliable safety assurance measures.

Gaps identified in the current research on the topic

The socio-economic problems addressed in the studies reviewed are mostly related to the food insecurity of consumers. The solutions proposed are typically food product development efforts aimed at a cost reduction of food items, optimization of the nutritional content of food items, and/or utilization of undervalued, indigenous and/or locally relevant food materials as well as the risk-prone practice of using sensory quality to judge food product safety. Consumer acceptance of the sensory properties of food product innovations is widely acknowledged and is the main motivation provided for including a sensory evaluation/consumer study component as part of the research.

In the majority of the studies, the physicochemical and nutritional characterization of products constitutes a more prominent focus and the consumer evaluation part is often included as a minor but necessary addition. The description of the methodology used for sensory and/or consumer evaluation often lacks important details (e.g. panel type, number of panellists included, the time of day when the test was conducted, the area/location for the test, detailed description of the quantity served and format of food servings) thereby making judgement on the validity of the findings difficult if not impossible. Exceptions are e.g. [22] that made specific mention that "the tests (with bread) were done at mid-morning when the testers were

neither too full nor too hungry". Considering that hunger is a common occurrence in low socioeconomic contexts such practical detail is of considerable importance. Some [13,26,27] but not all studies specified the language used for questionnaires. Keeping in mind that there are around 2000 languages or dialects spoken in countries in Africa [28], documented information on translated versions of questionnaires and scales in local languages is lacking and potentially very valuable.

The research reports reviewed often lack clear and complete information on methodologies applied. This includes the descriptions of the strategies used for the recruitment of consumers and inclusion qualification criteria employed. Test subjects that evaluated samples are not always truly representative of the target consumer market relevant for the research question under investigation. Examples are students at universities and staff members employed at research institutes being a convenient, easy-to-find and recruit group but rarely representative of the low-income population at which products are directed. Many studies included far too few respondents and/or not the correct respondents for the consumer evaluation task to substantiate any valid conclusions about the acceptability of the food items and target market under investigation. For example, Sobowale et al. [29] used only 20 subjects to evaluate the acceptability of sensory properties of 20 samples of cocoyam noodles while [30] concluded that functional instant soup mixes would be acceptable to the elderly based on the liking ratings of 10 trained staff members at a research institute. The liking of the sensory properties of catfish species with a "trained" panel of 20 catfish eaters [31] and evaluation of various tiger nut beverage options with a "trained" panel of 30 consumers [32] demonstrates the lack of familiarity of researchers with good standard sensory practices and terminology. While many studies focus on food products for infants due to the vulnerability of this group as far as nutrition is concerned, product evaluation by the real users, namely infants, is not done very often. The reasons for this may be the time, the appropriate materials (as camera for facial expression capture), effort and expertise required to obtain ethical approval when involving minors and the inability of this target group (infants) to provide verbal or written responses. The acceptability of food for infants is often evaluated by caregivers of the children aged 6-23 months (e.g. [33]). An exception is an extensive study in Tanzania [16] that involved paired preference tests of porridge made from extruded fortified blended foods (FBFs) with infants between 6 and 59 months. After tasting two products, trained enumerators asked each child to say or point to the sample they preferred. In the case of infants or children who could not respond, caregivers were asked to interpret their child's preference based on their body movement or facial expression.

There is also confusion identified of what the process of selection and training of a sensory panel implies. For Olaniyi et al. [31], the selection of trained panelists was based on the correct identification of an unidentified (blind-coded) but common juice. More training and exposure of researchers in African countries to the basic but also advance level sensory and consumer science methodologies and principles may address many of the gaps identified. The recent establishment of the African Network for Sensory Evaluation Research (acronym ANSWER) at the 13th Pangborn Sensory Science Symposium is a positive effort in this direction [33].

What approaches did researchers use when conducting consumer tests with low-income, food-insecure consumers?

Commonly used sensory test conditions are not always adapted to the needs of low-income populations. Here we discuss some approaches implemented by researchers related to testing methods and evaluation instruments, test respondents/participants, test product samples and test environment or context.

Test methods and evaluation instruments

There is a dearth of studies that specifically focus on the development and validation of test methods for use with low-income, food-insecure consumers. De Kock & Kamdem [34] developed the Kamdem paired preference method with the objective to design practical test methods specifically for use with low literate consumers. The authors motivated this focus on the fact that the literacy level and task proficiency of low-income consumers may be low to very low which may necessitate methods of information gathering adjusted to their needs.

Most studies applied the standard hedonic test rating scales with either 5 [35], 7 [26] or 9 [36,37] categories. Scale categories with descriptors ranging from like extremely to dislike extremely or very bad to very good [38], were applied. Olaniyi et al. [31] adjusted the traditional 9-point scale to using only the top 5 categories; 5 = Excellent/Like extremely 4 = Very good/Like very much 3 = Good/Like moderately 2 = Fair/Like slightly 1 = Neutral/Neither like nor dislike. This scale, however, does not provide any opportunity for disliking a sample. Moreover, providing more than one term descriptor per category could confuse respondents. The complexity of comprehension of the standard 9-point hedonic scale is the reason provided for shortening the scale to 5 or 3 categories. It is assumed that low-income consumers will potentially not be able to use the more complex, longer scale or will not have the reading skills required [39]. The use of pictorial smiley face scales is popular [13,27,40] motivated by the low literacy levels of many respondents representing this target market. These assumptions have not necessarily been tested and the practices not necessarily validated.

Adaptation of consumer test methods may be needed to handle limitations e.g. related to language capabilities for following instructions or for providing responses verbally or in written format. For example, Lagerkvist et al. [41] referred to the limitation of the local language (in Kenya) being sparse on emotional words with multiple meanings making it difficult to fully grasp consumer opinions and perceptions. The researchers employed a photo-elicitation interviewing technique where images are used to enable stimulation of emotions and abstract ideas from consumers. In the study, the technique was used to determine how the information provided influenced the expected and actual liking of the sensory properties of vitamin A-biofortified sweet potatoes.

Test Respondents/participants

The reliability of consumer acceptance data depends on the extent of representation of the test panel to reflect the opinions of a well-defined specific target consumer group. In communities of low socioeconomic status in many African countries, the involvement of community workers (e.g. nursing staff from clinics) and local leaders to gain access to the right respondents is very important [41]. For example [13] recruited caregivers of children 1-5 years by distributing invitation letters at pre-primary schools in a rural area in South Africa.

Lagerkvist et al. [41] emphasized the need for careful planning and pre-testing of protocols to limit participant confusion. The researchers also took practical steps in planning and scheduling to prevent the possibility of respondents discussing the experiment with other participants. Consumer opinions could be influenced by information provided to them about the products served for tasting. [27] tested consumer acceptance of novel protein-enriched (with hydrothermally treated soya) staple maize porridge but did not want the respondents to know that soya was added due to pre-conceived ideas about soya products among the specific target group. The researchers opted to individually screen potential test subjects by asking them if they have problems with common allergens including fish, pork, meat, egg, peanut, tree nut, wheat, and soy. Applying this strategy the potential of enriching maize-based stiff porridge with hydrothermally treated soybeans without compromising consumer acceptability was demonstrated.

Only a few studies [22,41] reported on the provision of payment, incentives or gifts for participation. A fresh approach for incentivization for participation was applied by Lagerkvist et al. [41] by informing participants at the end of the experiment that they could keep leftover, unused test material as reward for the time dedicated to the experiment. The researchers noted that this practice reduced the risk of participants responding positively merely because they expected an 'in-kind endowment.

Distribution of product samples

Lagerkvist et al. [41] incorporated various practical aspects in a consumer study with caregivers of small children and pregnant women, e.g. participants were provided with the usual glass of water to rinse their mouths between samples. However, to introduce a time delay and product distraction opportunity, a planned discussion about the benefits of drinking water was initiated as part of the study. In a resource-poor environment, Bechoff et al. [43] applied a practical solution to serving many samples simultaneously and economically by dividing a paper plate into 8 equal sections 'pizza-style' with a black marker in order to present the product samples, wrapped in plastic film, placed on the eight segments.

Test environment

It is well-known that the test environment can have an impact on responses and should be selected with care. Only a few studies described the nature of the area or space where consumer testing was performed [see 13,42]. Sosa et al. [39] found a significant effect on acceptance when comparing the results of tests conducted in a home location and in a central location (identical to laboratory condition). With two different food products, the tendency was for higher scores reported in the home location compared to the central location. The authors recommended using a central location with low-income populations. Consumers were more critical in a central location and paid more attention to the evaluation than in the home location.

In contrast, Lagerkvist et al. [41] specifically selected in-home testing for a consumer test in Kenya. To enforce product-use context, the researchers conducted a 'field experiment' in the home environment of participants where food preparation and consumption usually occur. The advantage was that fewer resources were required to prepare samples but, in addition, observation and discussion of practices used by participants and insights gained during the preparation of samples (boiling sweet potato roots) for eating, could occur. It reduced respondent task anxiety as participants used their own familiar cooking facilities and could focus on the evaluation task. However, a negative aspect of such context-rich experiments could be the time required to complete the experiment.

What modifications of test methodologies may be required when conducting consumer tests with low-income, food-insecure consumers?

When testing is conducted with consumers of low socioeconomic background, various aspects may need to be considered. Here we present some examples. Limitations on the educational level may influence literacy levels of respondents and the depth of understanding of the task/s that are required. This aspect potentially also lowers the proficiency to read, write and use technologies (e.g., computers, internet, social and other media) compared to consumers in advanced socioeconomic classes. More assistance from test administrators and more explanation may be required. This aspect was emphasised by a number of researchers e.g. [8,44] that reported the need for task-related orientation (termed 'training') of consumer test subjects prior to or during a product evaluation session.

Low-income consumers may be reluctant or not confident to react negatively to food stimuli during a food evaluation task. The consequence of this is the avoidance of the use of any negatively termed category points on a scale. This may lead to results that do not reflect the true feelings and opinions of the group of respondents. This phenomenon of “avoiding negative responses” may be the reason why [31] chose to use a 5-point unipolar hedonic scale (5 = Excellent/Like extremely 4 = Very good/Like very much 3 = Good/Like moderately 2 = Fair/Like slightly 1 = Neutral/Neither like nor dislike) without strong negative descriptors in to evaluate boiled fillets from a range of catfish samples (*C. gariepinus* and *H. bidorsalis*).

Scale usage (including the type of scale, number of categories, the addition of word descriptors or not) by low literate and/or food insecure and/or low educated adult consumers has received little attention in this research field. Sosa et al. [39] motivated the use of a 10-point hedonic scale as it is a more familiar rating system used daily for many situations. For example, children’s tests in schools are graded out of 10. The consumers also found a number scale more familiar and easier to use than a scale with only word descriptor requiring more ‘reading skills’. The choice of scales to use with low-income populations should be fit the educational level of subjects: easy to understand and to use.

Conclusions

We conclude that acceptability of food products for undernourished, economically-disadvantaged consumers demand the same (if not more) attention from a sensory point of view as those items intended for nutrition secure, high-end consumers. More research is needed to develop and validate test methods and test environment conditions applicable for use with low socioeconomic groups that may have received limited schooling, have low literacy levels and may require more direction and guidance towards food evaluation and test procedures. Studies that investigate the food choice motives of consumers in different African countries are necessary to better align food choice determinants and drivers of liking/disliking with food product development and nutrition intervention strategies. Sensory and consumer science researchers in African countries are encouraged to learn from and to adapt global best practice principles and apply these to the specific circumstances and challenges that they face on the African continent.

Conflict of Interest:

The authors declare no conflict of interest.

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