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Sensory Acceptability and Factors Predicting the Consumption of Grain Amaranth in Kenya

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This study investigated the effect of adding grain amaranth flour on sensory acceptability of maize porridge in Kenya. Factors influencing the intention of mothers to feed their children on grain amaranth were identified. A significant difference between the various porridge ratios (50:50, 70:30, and 100:0 amaranth:maize) either in unfermented or fermented form could be detected. Preference for the unfermented amaranth enriched maize porridge was observed. Intention significantly correlated and predicted grain amaranth consumption ($p < .001$). Knowledge and health value significantly predicted health behavior identity. Interaction between barriers and intention negatively influenced behavior. Findings suggest that unfermented amaranth enriched maize porridge is acceptable. Unfermented porridge with 70% amaranth can be considered for use in a program aimed at increasing dietary iron intake among children. Increasing

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awareness about micronutrient deficiencies and nutritional benefits of grain amaranth could enhance its consumption.

KEYWORDS grain amaranth, porridge, acceptability, Kenya

INTRODUCTION

Maize meal in the form of porridge or *ugali* (stiff maize porridge) is a predominant complementary food in eastern and southern Africa contributing to most of the energy and micronutrient such as iron and zinc intake among children (Faber et al. 2005; Macharia-Mutie et al. 2010; Onyango et al. 2004). The use of maize as the principal ingredient suggests that children may be at risk of inadequate micronutrient intake especially iron (Faber and Benadé 2001; Hotz, Gibson, and Temple 2001). Inadequate intake of iron rich foods as well as low bioavailability of iron in the maize porridge contributes to occurrence of iron deficiency and iron deficiency anaemia (Cook 1990). Iron deficiency anaemia is known to be a significant public health challenge especially for growing children in the developing countries (WHO and UNICEF 2004). To improve the nutrient quality of maize porridge as a complementary food, thereby increasing iron intake and absorption, various strategies have been proposed. These strategies include fortification, enzymatic degradation of phytic acid, fermentation and dietary diversification (Davidsson 2003; Faber et al. 2005; Gibson and Hotz 2001). Dietary diversification may include increased consumption of ascorbic acid rich fruits and vegetables or other foods known to have high micronutrient content such as grain amaranth (*Amaranthus spp*). Grain amaranth is reported to be rich in proteins and iron therefore having a potential of improving the nutritional value of complementary foods (Akingbala et al. 1994; Escudero et al. 2004; Chavez-Jauregui, Silva, and Areas 2000).

Grain amaranth is a pseudo-cereal that was widely cultivated in pre-Columbian America and matures within a short period (Chavez-Jauregui et al. 2000; Escudero et al. 2004). Presently, it is cultivated for both its seeds and leaves in different regions of the world including Kenya (Mwangi 2003; Chavez-Jauregui et al. 2000; Escudero et al. 2004; Government of Kenya [GOK] 2007). Although grain amaranth has been promoted as a healthy food and a source of extra income for small scale farmers in the semi-arid areas in Kenya (GOK 2007; Mwangi 2003), the effects of addition of grain amaranth flour to the ordinary maize porridge on the sensory acceptability is largely unknown.

A food product must also be socially and culturally acceptable to achieve its intended objective on the target consumers. Though consumption of grain amaranth has been promoted in Kenya, there is no information available on which factors predict the intention to consume

grain amaranth. Models based on Theory of Planned Behavior (TPB) and the Health Belief Model (HBM) have previously been used to predict factors in health and nutritional behavior studies (Hanson and Benedict 2002; Sun et al. 2006; Nejad, Wertheim, and Greenwood 2004; Kim, Reicks, and Sjoberg 2003; Giles et al. 2007). The core assumption of the TPB model is that intention is the primary determinant of behavior (in this study consumption of grain amaranth) and that this is a function of one's attitude towards that behavior (Ajzen 1991; Giles et al. 2007; Armitage and Conner 2001), social pressure from 'important others' to consume the grain amaranth or not (subjective norms) and perception of one's ability to perform the given action (perceived behavioral control; Giles et al. 2007; Ajzen 1991; Kim et al. 2003). The HBM is a health specific model which proposes that health behaviors are the result of a set of core beliefs (McClenahan et al. 2007). These beliefs include supposed vulnerability to a disease and the subjective risk of acquiring an illness if no preventive measures are taken (perceived susceptibility) and supposed physical and social consequences of getting the disease (perceived severity). A perceived benefit (health behavior identity) which reflects whether the person thinks that performing a particular behavior is good and barriers of the preventive behavior to reduce risk or seriousness of impact also form part of the health beliefs in HBM model and are categorized as internal factors in the model of Sun and colleagues (2006). Cue to action refers to triggers due to awareness of a threat forcing need to take action while control represents confidence of having an ability to take action (McClenahan et al. 2007). Perceived barriers are expected to influence the translation of intention to actual behavior (i.e., grain amaranth consumption; Armitage and Conner 2001).

The objective of this study therefore was to investigate the effect of addition of grain amaranth flour on sensory acceptability of maize porridges in a rural Kenya setting. We also aimed at identifying factors influencing the intention of mothers to feed their children on grain amaranth using the integrated model as proposed by Sun and colleagues (2006) with modifications. Since grain amaranth is increasingly being used in Kenya, more research about the sensory characteristics of maize porridges enriched with grain amaranth flour is required. Information obtained on sensory properties such as taste and color will influence future promotional activities for grain amaranth production and consumption in relation to its iron content.

MATERIALS AND METHODS

Study Area

The sensory and social acceptability studies were carried out in Migwani division of Mwingi District and Makuyu division of Murang'a South District, Kenya, respectively. Migwani and Makuyu are semi-arid areas located to the

east and north of Nairobi respectively. Participants gave verbal informed consent to participate in the study. Research authorization was given by Ministry of Higher Education, Science and Technology, Kenya.

Sensory Evaluation Study

Sixty participants consisting of 21 adults who had a child less than two years of age and 39 teenagers took part in this study, with an average age of 21.6 ± 10.9 years. The inclusion criteria for the teenagers were that they had to be older than 12 years of age and in seventh or eighth grade. The adults were randomly recruited from the study area through home visits and participation was voluntary. The participants received instructions about the test and the forms to be completed before starting the evaluation.

Preparation of porridges

Milled white maize flour (80% extraction rate) enriched with milled whole grain amaranth flour was used in this study. Both maize and grain amaranth flours were bought separately from a local supermarket in Nairobi, Kenya. Porridges with three different proportions of grain amaranth and maize flour were prepared so as to investigate which ratio of grain amaranth:maize flour would be most acceptable in a proposed intervention study. The porridges were prepared either in fermented or unfermented form. Based on the need to use the composite flour with the highest possible iron content in the intervention study, the lowest sample ratio used in this study was 50% grain amaranth flour mixed with 50% maize flour (50:50). To assess whether addition of more than 50% amaranth is acceptable, porridges with 70% (70:30) and 100% (100:0) amaranth were included in the study.

To get the different flour ratios, manual mixing of both maize and grain amaranth flour was done for approximately 5 minutes for each ratio (i.e., 7 kg amaranth and 3 kg maize to give 70:30 ratio and 5 kg amaranth and 5 kg maize to give 50:50 ratio). The resulting mixture of 10 kg for each ratio was used throughout the trial. Visual examination was done to check for even distribution of the amaranth flour in the maize flour. Cooking of both the fermented and unfermented porridges was done on the day of the test. To make the unfermented porridge, a smooth slurry, prepared by adding flour to 1 liter of cold water, was poured into about 5 liters of boiling water in cooking pots and the mixture was stirred for at least 15 minutes till the porridge formed a smooth paste. To make the fermented porridge natural fermentation was done by preparing a smooth slurry with 2 liters of warm water and approximately 350 g of each flour ratio three days before the actual cooking. The prepared slurry was poured into plastic jerry-cans and left to ferment at room temperature until use. On the day of test, the fermented slurry was mixed with some more flour and 1 liter of cold water.

The resulting fermented slurry was then poured into about 5 liters of boiling water in cooking pots and the mixture was stirred for at least 15 minutes until the porridge formed a smooth paste.

To ensure that the porridges had comparable consistency, the total amount of water (6,300–8,000 ml), flour (524–1000 g) and the cooking time (18–36 minutes) were adjusted for each of the porridges depending on the flour ratio used. The porridge with more amaranth tended to have a thinner consistency and therefore more flour and less water was used for this porridge. As much as possible we controlled for consistency through visual examination by checking the fluidity of the porridge. The cooked porridges were kept in jerry-cans to maintain the serving temperature.

Sensory tests

Discrimination test was done by the participants in two triangle test sessions on separate occasions one week apart. The first test session consisted of triangles of unfermented grain amaranth enriched porridge. In the second session, the triangles consisted of fermented amaranth enriched porridge. In each session, six different triangle combinations were offered. The sequence of combinations was counterbalanced across participants. Three samples were presented simultaneously to the participants of which two samples were identical and one was different. Each subject had to indicate which sample was the odd one based on their assessment through mouth feel and taste but they were not to report which specific attribute was different in the forms provided. The porridges were covered and the participants were not allowed to open more than one lid of the serving bowls at the same time. Our tests were based on an alternative hypothesis that the probability that the participants will make the correct decision when they perceive a difference between samples was to be larger than one out of three (i.e., H_a:$P_t > 1/3$; Heymann 1998).

Paired preference test using nine pairs of porridge was done by each participant one week after the second discrimination test. During this test, participants received two samples with different ratios of grain amaranth flour and were requested to indicate the sample they preferred in the provided form. The participants were requested to compare color, smell, and taste. Re-tasting was allowed during this test and the participants were not forced to eat the whole sample. We hypothesized that the participants will prefer the porridge with the lowest amount of added grain amaranth flour (i.e., H_a:$P(A) \neq P(B)$; Heymann 1998).

Social Acceptability Study

One hundred and fifty women (mean age 31 ± 7.9 years) randomly selected from Makuyu Division of Murang'a South District participated in

this sub-study. The participants complied with the inclusion criteria of being a mother/caregiver of a child 1 to 3 years of age, who was familiar with and had consumed grain amaranth before. Mothers were considered in this study as key respondents, since parental consumption has been reported as a strong determinant for children's food consumption.

Questionnaire

The questionnaire consisted of 131 items identified through a literature search on grain amaranth and 10 questions on sociodemographic profile. The items were categorized into 12 constructs according to the model by Sun and colleagues (2006; figure 1). The constructs were further grouped into background and perception, beliefs and attitudes, external factors, and intention and behavior. Each item was translated into a statement, either positively or negatively stated depending on the construct, and the respondents were asked to indicate their level of agreement or disagreement on a Likert scale. Items of most constructs were scored from 1 to 5. However, for the

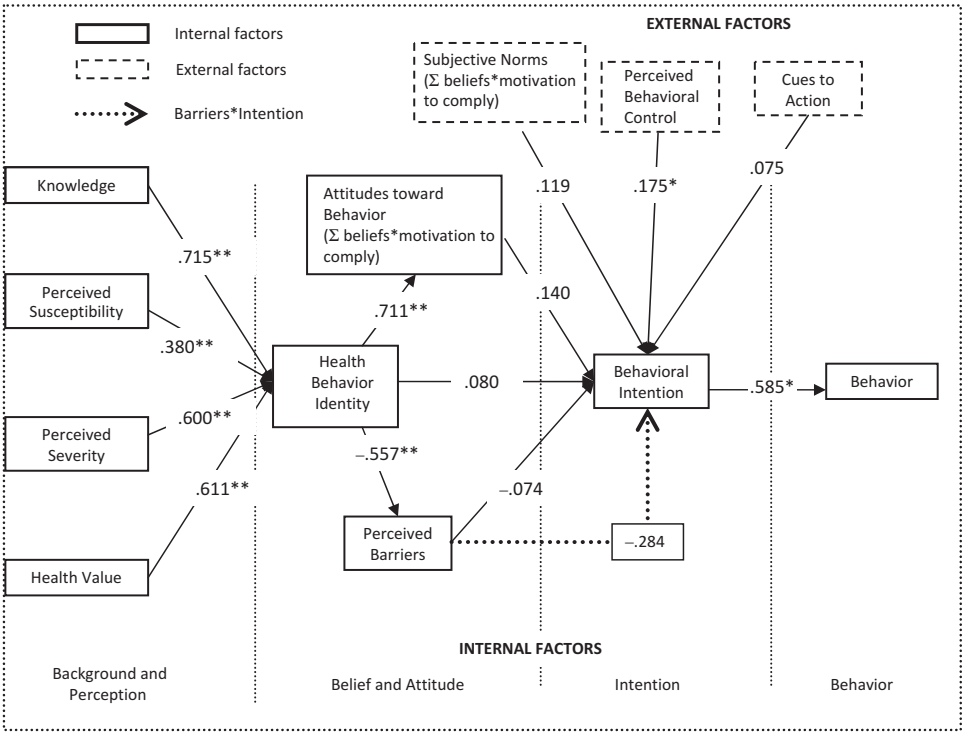

FIGURE 1 Correlations of the various constructs using the combined health belief and theory of planned behavior models. *Note*. Model adopted from Sun and colleagues (2006). *Correlation is significant at the .05 level (two-tailed). **Correlation is significant at the .01 level (two-tailed).

constructs *attitude towards behavior* and *subjective norms*, items consisted of pair statements with answer categories ranging from1 to 5 and −2 to 2. The scores of the pair statements were then multiplied to derive one score for each item ranging from −10 to 10. The questionnaire was translated into the local language (Kikuyu) and correctness checked with back translation into English. Pre-testing was done with eight women who were not part of the final study group. No change of the questionnaire was necessary after the pre-test.

Statistical Analysis

Data analysis was performed with the Statistical Package for Social Sciences (SPSS 15.0 for Windows) and MS Excel. For sensory evaluation data the responses of our participants were not independent from each other as they tasted the product six times. Therefore probability of variance from within and between persons existed. This multiple variance referred to as over dispersion is measured by gamma (γ), a value that ranges from 0 to 1. When γ is significantly greater than 0, the beta-binomial model should be used to avoid an underestimation of the standard error, otherwise the binomial model would be used. Moment estimation was used to calculate gamma (γ) and Tarone's Z statistic was used to check whether this γ was significant. Since there was no significant subject variability, the binomial distribution model was used for analysis. To check whether the critical minimum value of correct or agreeing choices needed for significance was achieved (49 out of 120 judgments), reference was made to statistical tables on critical values (Bi and Ennis 1999; Jian et al. 2000; Ligette and Delwiche 2005).

For social acceptability data, descriptive statistics were carried out. Median scores were used to show the trends in answers per construct. Reliability analyses were carried out to evaluate internal consistency within the constructs. Consistency was achieved when the correlation coefficient Cronbach's alpha (α) was .80 or higher for the complete set of items in a construct. Each single item had to be higher than .30 on the corrected item-total to remain in the set. If an exclusion of an item resulted in a considerable increase on Cronbach's α value for the total item set, the item was excluded for this and further analysis to enhance the consistency of construct. In total 19 items were excluded as follows: knowledge (1 item), susceptibility (1 item), barriers (12 items), attitudes (2 items) and cues (3 items). For each respondent the item scores within a construct were added to derive a total score per construct (table 1).

Spearman's correlation was done to examine the level of agreement within the integrated model of TPB and HBM. Wilcoxon signed-rank test was used to compare the scores of the item under intention to consume grain amaranth and the item consumption of grain amaranth, hence to test whether the participants significantly change their response in one direction (i.e., if score intention is > or < score behavior). Multiple regression analysis

TABLE 1 Internal Consistency and Median Scores of the Responses Per Construct ($N = 150$)

Construct	Number of items (Cronbach's $\alpha > 0.3$)	Cronbach's α (complete set)	Median	25th	75th	Range[a]
Knowledge[b]	10	.87	47	40	50	11–55
Perceived susceptibility[b]	3	.81	12	11	14	4–20
Perceived severity[b]	15	.84	67	60	72	15–75
Health values[b]	13	.91	63	57	65	13–65
Health behavior identity[b]	3	.95	14	12	15	3–15
Perceived barriers[c]	10	.90	−6	−14	2	−50–50
Attitudes towards behavior[d]	7	.92	60	35	70	−100–100
External control belief[b]	4	.75	20	16	20	4–20
Cues to action[b]	8	.80	30	26	34	11–55
Subjective norms[e]	10	.83	46	34	53	−100–100
Behavioral intention[f]	3	.97	15	15	15	3–15
Prior behavior[f]	2	.98	10	8	10	2–10

[a]Range refers to the minimum and maximum possible scores from complete set of questions within a construct before consistency evaluation, except d and e, whose scores were from paired questions.
[b]scores ranged from 1 = strongly disagree to 5 = strongly agree.
[c]scores ranged from 2 = strongly disagree to −2 = strongly agree.
[d]*Bb* (behavioral beliefs) items ranged from 1 = strongly disagree to 5 = strongly agree * *Oe* (outcome evaluation) items which ranged from −2 = strongly disagree to 2 = strongly agree.
[e]*Nb* (normative beliefs) items ranged from 1 = very unlikely to 5 = very likely * *Mc* (motivation to comply) items which ranged from −2 = strongly disagree to 2 = strongly agree.
[f]items ranged from 1 = none to 5 = more than 2 times a week.

were carried out to examine how much variance was explained by different models, and to determine which constructs significantly predicted intention. Four models used were:

model 1: identity = knowledge + susceptibility + severity + values;
model 2: intention = identity + barriers + attitude;
model 3: intention = norms + control + cues to action; and
model 4: behavior = barriers + intention + (barriers*intention).

All models were adjusted for interviewer, place of residence, respondent's age and level of education, by including them in the models. Multi-co linearity was checked through variance inflation factor (VIF) and tolerance. No changes were necessary because VIF was < 10 and tolerance was > 0.1. A value of $p < .05$ (95% CI) was considered statistically significant (Field 2005).

RESULTS

Sensory Evaluation

In the discrimination tests, the participants were able to detect a significant difference between all the ratios in both the unfermented and fermented amaranth enriched maize porridges ($p < .05$; table 2). In the fermented

TABLE 2 Results for the Two Triangle Tests with Six Replications for Different Amaranth: Maize Ratios among Children and Adults in Mwingi District[1]

	Porridge ratio					
	50:50/70:30		70:30/100:0		50:50/100:0	
Description	Unfermented porridge	Fermented porridge	Unfermented porridge	Fermented porridge	Unfermented porridge	Fermented porridge
Subject variability (γ)	.19	<.0001	.004	.09	.10	.09
Number of correct responses observed	64*	64*	57*	80*	67*	87*
Triangle μ Test: $\mu = \frac{1}{3}$	.53	.53	.48	.66	.56	.73

[1]Maximum number of responses = 120; Number of responses needed for significance ($\alpha = .05$) = 49.
*significant ($\alpha = .05$) using Tarone's Z statistic.

porridges more participants detected a difference when comparing 50:50 and 70:30 to 100:0; however, when comparing 50:50 with 70:30, there was no difference in number of participants detecting a difference.

In the paired preference tests no subject variability was calculated because every subject tested the different comparisons only once and the binomial model was used. With the fermented porridges, the lower ratio was always preferred indicating that 50:50 was preferred above others. With the unfermented porridges both lower ratios were preferred above 100:0 but no preference was seen between 50:50 and 70:30.When comparing the unfermented with the fermented amaranth enriched maize porridges, for all the ratios a preference was found for the unfermented porridge (table 3).

Social Acceptability of Grain Amaranth Porridge

The main sources of grain amaranth was buying (85.3%) and own cultivation (27.3%). More than three quarters of the respondents (80%) had the intention to feed their children grain amaranth, two or more times a week, during the next 6 months while 72% had fed their children with the grain during the past 6 months, two or more times a week. Although the women scored slightly higher on intention than behavior, Wilcoxon-signed rank test showed that there was no difference between the reported intention and behavior ($p = .027$).

The opinion scores of the constructs were high compared to the range of possible scores (table 1). Most respondents agreed that grain amaranth contains iron (97.3%), and that its use can prevent iron deficiency/anaemia (90.7%). They also associated iron with the health of young children (99.3%). Although most women agreed that in general adult women and young children easily suffer from iron deficiency, most (90.7%) did not find themselves at risk. A small percentage of women did not agree that iron deficiency will lead to health problems in later life (5%), that iron deficiency can affect intelligence (18.7%) or that adults with iron deficiency will have lower work capacity (2.6%). Most of the women indicated that they were the ones who decided what is good for (99.3%) and what food to give to their child (96%). More than 30% of the women strongly perceive the availability of grain amaranth on the market (34%), the availability throughout the year (40.7%), not finding the right amaranth variety (35.3%), not finding amaranth of good quality (36%) and not having skills (32.7%) or tools (30%) to cultivate amaranth grains, as barriers. However, more than 30% of the women also feel that grain amaranth can be easily grown on the farm (39.3%), cooking grain amaranth is easy (57.3%), that color (59.3%) and size of the grain (66.7%) were not determining whether or not to buy amaranth grains, that amaranth does taste well (45.3%), has a good texture (42%) and is easy to digest (65.3%). The following beliefs were stated by more than half of the women: grain amaranth has nutritional qualities (59.3%); eating grain amaranth is

TABLE 3 Results of the Preference Tests for Different Ratios of Amaranth Enriched Maize Porridge among 60 Participants in Mwingi District

	Porridge ratio								
Description	F 50:50/ F 70:30	F 70:30/ F 100:0	F 50:50/ F 100:0	U 50:50/ U 70:30	U 70:30/ U 100:0	U 50:50/ U 100:0	F 50:50/ U 70:30	U 50:50/ F 70:30	U 70:30/ F 100:0
Appropriate model	Binomial	Binomial	Binomial	Binomial	Binomial	Binomial	Binomial	Binomial	Binomial
Number of responses needed for significance	39	39	39	39	36	37	39	39	39
Number of responses favoring first stated ratio	40*	42*	54*	26	36*	44*	22	46*	52*
	(F50:50)	(F70:30)	(F50:50)	(U50:50)	(U70:30)	(U50:50)	(F50:50)	(U50:50)	(U70:30)
Paired Preference Test: $\mu = {}^{1}/_{2}$	.67	.70	.90	.43	.63	.76	.37	.76	.87

F = Fermented porridge, U = Unfermented porridge.
*significant ($\alpha = .05$).

good to prevent diseases (58.7%), grain amaranth is good to gain weight (54%) and stimulates appetite (49.3%). Grain amaranth is not seen as a food for poor (46.7%) neither for rich (32.7%). Although women find it important to feed children traditional food (65.3%) that is own cultivated (68%), about 25% of the women do not see grain amaranth as a traditional food while more than 68% do not cultivate grain amaranth on their farm. Illness of household members (43.3%) and especially children (50%) would trigger a woman to feed her child grain amaranth as well as household members (46.7%) and children (53.3%) having iron deficiency. Grain amaranth is not a food specially used during special events or celebrations (72%). According to the women, an upcoming food shortage, grain amaranth sellers or radio advertisements could make them want to eat amaranth (24.7%). Advice from either the husband (59.3%) or a nurse (48.7%) would influence nearly half of the women to give their child grain amaranth. Opinions of friends, neighbors and other women in the community were much less important according to the respondents.

Figure 1 shows the correlations between the constructs of the model. All the variables within background and perception significantly correlated with identity with knowledge having the highest correlation ($r_s = .715$, $p = .000$). A high identity was significantly correlated with a positive attitude ($r_s = .71$, $p < .01$) and with a low level of perceived barriers ($r_s = -.557$, $p < .01$), but none was correlated with identity. Among the external factors, only control (perception of how easy or difficult it is to feed their children grain amaranth) was significantly correlated with behavioral intention ($r_s = .175$, $p < .05$).

The relative contribution of the variables to behavior is shown in table 4. The constructs within our study explained only a small variance in predicting intention. Fifty-eight percent of the variance of health behavior identity could be explained by background and perception (model 1), of which knowledge about the relationship between iron deficiency/anaemia and grain amaranth ($\beta = .60$, $p = .00$) and the relative significance given by the person to the health consequences of suffering from iron deficiency anaemia (health value, $\beta = .31$, $p = .00$) were significant predictors of health behavior identity. In models 2 and 3, none of the included constructs could significantly predict intention with only 18% and 31% of the variance explained respectively. Forty-seven percent of the variance in grain amaranth consumption could be explained where only the construct intention could significantly predict behavior ($\beta = .69$, $p = .00$). Although interaction between barriers and intention had a negative influence on this last model, this interaction was not significant.

DISCUSSION

The first objective of this paper was to investigate the effect of addition of grain amaranth flour on the sensory quality of maize porridges in a

TABLE 4 Predictors of Health Behavior Identity, Intention to Consume Grain Amaranth, and Prior Consumption among Women in Murang'a South District, Kenya

Model[a]	Standardized β	p	R^2	Adjusted R^2
Model 1 (Y = Health behavior identity)			.593	.576
Knowledge	.603	.000		
Perceived susceptibility	.055	.362		
Perceived Severity	−.022	.805		
Health Values	.310	.002		
Model 2 (Y = Behavioral intention)			.038	.018
Health Behaviors identity	.137	.271		
Barriers	−.065	.510		
Attitudes towards behavior	.017	.886		
Model 3 (Y = Behavioral intention)			.050	.031
Subjective norms	.055	.564		
Perceived behavioral control	.162	.063		
Cues to action	.075	.409		
Model 4 (Y = Prior behavior)			.482	.472
Barriers	.247	.343		
Behavioral intention	.689	.000		
Barriers * Behavioral intention	−.238	.362		

[a]All models adjusted for interviewer, place of residence, respondent's age, and level of education.

rural Kenya setting. Our results indicate that significant differences could be detected between all the porridges.

The participants used in our study were all above 12 years and therefore their cognitive skills were considerably good to provide the information required. To prevent odd sample bias in our tests, the odd sample was randomly assigned between the two similar products as follows; ABA, BAA, BBA, AAB, ABB and BAB. This reduced the probability of having only one type of porridge (ratio) as the odd one. Furthermore, there was at least one week in between the discrimination as well as the preference tests. The one week difference was expected to reduce the effect of the odd sample bias as the participants may not have been remembering the previous odd sample.

A possible limitation during the triangle test in our study was that the lids for the serving bowls had different colors. As much as possible, we covered the bowls with lids of similar colors for each subject. There were however some instances (< 5% of the test settings) when two lids had the same color and one lid was different in the test setting of one person. Where more than one color of lids had to be used we ensured that similar colors did not correspond to any particular ratio. To further reduce the effect of lid colors we emphasized to the participants prior to the test that the colors of the lids were not of importance for their choice.

Grain amaranth flour has a slightly darker color than maize flour and therefore the porridge with more amaranth was slightly darker. To reduce the influence of porridge color differences on the choices made by the participants, the samples were all covered and the participants were allowed to

open one lid at a time. However, there is a probability that the respondents could sometimes remember the color of the other porridges. It is then possible that though the discrimination test was based on mouth feel and taste, the choice was also influenced by the porridge color.

The responses of the paired preference test cannot only be based on the taste of the products but also on visual characteristics such as consistency, or the smell of the porridge. As such, the participants were allowed to use all their senses such as sight, smell, and taste. The statistical analysis took into account that there is 50% chance of preferring any of the two products (porridges) presented for testing when in reality there was no significant difference perceived between them. Since this chance was randomly assigned over the participants and our preference test was not only based on taste but also on smell and sight, it was expected that the effect of choices made would not lead to incorrect conclusions.

Other studies have shown that 15%–20% of the flour used for making bread and conventional pound cakes could be replaced by grain amaranth flour without negatively affecting the sensory attributes (Ayo 2001; Capriles et al. 2008). In this study, the minimum amount of amaranth flour added to the maize porridge was 50%. Based on the need to use a composite flour with the highest possible iron content from grain amaranth in a proposed intervention study we therefore did not compare the enriched amaranth maize products to the usually consumed plain maize porridge. The porridge with highest ratio (100:0) of amaranth was least preferred. This could be due to the intrinsic nutty taste of amaranth, which may not be familiar to the participants (Mwangi 2003). Although using hedonic tests, a similar low acceptability in cakes has been observed when more amaranth flour was added during their preparation in Brazil (Capriles et al. 2008).

The second objective of this study was to identify factors that significantly predict the intention of mothers/caregivers to feed their children grain amaranth in Makuyu division using an integrated model of the TPB and HBM (Sun et al. 2006). In the present study the constructs explained only a small variance in predicting intention. The novelty of grain amaranth may explain the low contribution of the constructs to the prediction of intention in this study. Though the theory of planned behavior model requires participants to describe their cognitions, this requirement is based on the assumption that the answers given will reveal pre-existing states of mind (Armitage and Conner 2001). Thus if the behavior is novel and unfamiliar it is possible that the cognitions may be created simply by completing a questionnaire (Ogden 2003). In our study we sought to reduce the effect of unfamiliarity by setting certain requirements for participation (i.e., knowing and having eaten the grain). However, the target population was still not entirely familiar with the consumption of grain amaranth. The majority of the respondents had tried it in the past but more as a sporadic event rather than a regular behavior. Grain amaranth has recently been

introduced to the Kenyan market and although it is currently commercialized and sold in major supermarkets in Nairobi, this has not yet reached many rural areas. In addition, grain amaranth was only being grown and sold by a small group of farmers in the study area. High opinion scores compared to the range of possible scores were observed indicating that most respondents tended to agree with the statements. Unfamiliarity and tendency of the respondents to agree rather than disagree with the statements may reflect difficulty in discriminating opinions implied by response categories provided (Marin and Marin 1991). It may also reflect cultural or linguistic ambiguities in what is meant or intended by the question (Marin and Marin 1991). It may be that there are also no strong believes and attitudes attached to consumption of grain amaranth yet. Lack of strong beliefs makes it difficult to set a level of agreement or disagreement towards statements, as the behavior is not yet incorporated in the respondent's habitual context.

The observation that knowledge and health values significantly predicted intention indicates that the respondents would take a concrete health related action if they acknowledge the threat of a disease. The construct health values, has been reported as a significant predictor to take action related to health checks as in general practice (Norman 1995). This indicates the extent to which the respondent values their health. This study supports these findings, as the respondents have a positive attitude towards the value of health, in particular for their children, which may be reflected in actions aiming to ensure their health. Knowledge, from a wider scope, is a determinant factor to trigger engaging actions towards healthier behaviors in this population.

Intention was used in our study as a predictor of prior behavior, which in turn is a proxy for future behavior. This has similarly been used in other studies assessing intended food choice (Towler and Shepherd 1991). However, to our knowledge, there are no studies yet on grain amaranth consumption that confirm intention as a predictor of behavior and therefore these findings must be taken cautiously. Two potential drawbacks are encountered when measuring intention and behavior with self-reported questionnaires. First, answers given by the respondent on both constructs may be leading correspondingly, due to the similar way of wording resulting in an overestimation of the relationship (Sutton 1998). Second, when behavior is self reported it explains a larger part of the variance than when behavior is objectively measured, suggesting that individuals may provide socially desirable answers (Armitage and Conner 2001). Though there could be an existent and strong linear relationship between a particular intention and behavior in the population, when people with fairly or very strong intentions to perform the behavior volunteer for the study, the observed correlation and percentage of variance explained in the sample will be lower

than that in the population (Sutton 1998). Chances of this occurrence in our study were reduced by randomly selecting the participants.

The significant correlation of control with behavioral intention indicates that women in this study area are empowered to make decisions regarding grain amaranth consumption. The construct subjective norm was not a good predictor of behavioral intention and has reported as a generally weak predictor of intentions (Armitage and Conner 2001). In addition, African societies emphasize on communality and interdependence thereby, accentuating the importance of a referent group influence, especially in the domain of food choice (Jemmott, Jemmot, and O'Leary 2007; Åstrøm and Masalu 2001). It was therefore expected that social pressure would play an important role in intention for this population. However this trend was not observed in our study.

In conclusion unfermented amaranth enriched maize porridge is acceptable for women to give to their children. The porridge with the highest amount of amaranth, the unfermented 70:30 porridge, can be considered as a suitable food to be used in a food based approach program aimed at increasing dietary iron intake among children. The constructs explained only a small variance in predicting intention but none significantly predicted intention. Though knowledge and health value were significant predictors of health behavior identity, this did not significantly predict intention to consume grain amaranth. To promote grain amaranth consumption therefore, increasing awareness about micronutrient deficiencies and nutritional benefits of grain amaranth (knowledge) as well as health consequences of the deficiencies (health value) could be targeted.

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