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Consumers' Acceptance of Traditional Dishes from Quality Protein Maize in South West Ethiopia: Jimma Zone

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Abstract
The most important factor that drives to massive adoption of new agricultural food related technology is its sensory quality among users. The aim of the study was to evaluate consumers' sensory preference for quality protein maize in southwest Ethiopia. The study used three sensory evaluation techniques namely central location test, triangular test and modified home-use test. Data for central location test was collected from randomly selected 192 assessors and for modified home use test, 210 randomly selected women who have 6-23 month children were participated. In addition, 16 consumers randomly selected were also participated on triangular test. The data from central location test and modified home use test was analyzed using paired sample t-test using SPSS-20 and data from triangular test was analyzed using binominal distribution. Factors affect farmers` preference of maize dishes was analyzed by ordinal logistic model. The result from triangular test shows significant sensory difference between quality protein maize and conventional maize dabo and the result from central location test and modified home-use test explored quality protein maize dishes was appreciated than the conventional counterparts. The overall score of children also realized quality protein maize genfo was appreciated than the conventional maize genfo. The result of the study also shows that taste highly and significantly affect mother's overall ratings than any of other attributes. The study finally recommends researchers, extensionists and organizations working in the area of food security and poverty reduction to use the sensory acceptability of quality protein maize to disseminate and diffuse the technology and finally to tackle malnutrition.
Keywords: Binominal distribution, Central location, Modified home-use, ordinal logistic Sensory, triangular

Background and justification
Child malnutrition in the long run is a threat to economic growth in developing countries. It undermines educational attainment, lowers non-cognitive skills, leads to low labor productivity during adulthood, and diverts attention and resources away from other development objectives (Save the Children, 2012; Dercon and Sanchez, 2013). More than 13.7% Ethiopian populations are children under five years of age. These children and their mothers suffer from poor health and nutrition situation in the country. The national demographic health survey conducted by central statistical agency in 2014 showed that the prevalence of wasting[1], under-weight[2] and stunting[3] was: 9%, 25% and 40% respectively (CSA, 2014). Protein energy malnutrition, vitamin A deficiency, iodine deficiency disorders, and iron deficiency /anemia/ are the most common forms of malnutrition in Ethiopia (Edris, 2004). To tackle the problem of malnutrition in poor nations, a number of targeted interventions have emerged. Broadly, four strategies are most commonly used to overcome nutrient deficiencies namely; dietary intervention or diversification, fortification, supplementation and bio-fortification (WHO/FAO, 2006).

Quality protein maize (QPM) is a bio fortified maize variety with high lysine and tryptophan and proved to have positive results towards malnutrition (Gunaratna et al., 2008). Since the discovery of QPM, various experiments on rats, children and adults were conducted to examine its nutritional impact (Graham et al., 1990, Bressani, 1991). The result shows that QPM based feed has significant positive result on weight and height of the animals (Burgoon et al., 1992; Gunaratna et al., 2008).

The most important factor that drives to massive adoption of new food related agricultural technology is its sensory quality among users which is evaluated by consumers using different sensory evaluation techniques.

The main objective of this study is to identify consumers` sensory preference for QPM and the conventional maize based traditional dishes in southwest Ethiopia; Jimma zone and Omo Nada district and the specific objectives of the study are:

- ✓ To examine if consumers can identify sensory differences between *dabo* made of different varieties of QPM and conventional maize.
- ✓ To identify consumers` acceptance of QPM and conventional maize traditional dishes.
- ✓ To investigate determinants of consumers` sensory preference of maize based traditional dishes.

The rest of this paper is organized under four sections. Section two presents key concepts like sensory evaluation and empirical framework. Section three discussed issues related to data such as survey design, data collection and

[1] Insufficient weight for height, an indicator of acute under-nutrition (FAO, 1997)
[2] Insufficient weight for age which could be a result of both stunting and wasting (FAO, 1997)
[3] Insufficient height for age indicating chronic under-nutrition (FAO, 1997)

data analysis methods used. Section four focuses on interpretation and discussion of results and section five summarizes the study and presents conclusions and recommendations as well as future directions.

Review of literature: Consumers' food acceptance and preference

Acceptance of a food is basically the result of the interaction between food and man at a certain moment. This sensory and quality characteristic of foods used to designate consumers' food acceptance, liking, choice, acceptance and preference is identified by sensory evaluation (Lawless and Heymann, 2010). Sensory evaluation is "a scientific method used to evoke, measure, analyze and interpret those responses to products as perceived through the senses of sight, smell, touch, taste and hearing" (Anonymous, 1975). The reaction and the outcome of the evaluation such as flavor, taste, appearance, texture, temperature, color, odor and aroma are called the sensory attributes (Blades, 2001). There are three methods of sensory evaluation techniques based on the environment in which assessment is conducted namely laboratory tests (e.g. triangular test), central location tests or home-use tests (Meilgaard et al., 2007:263).

Central location test is a way of conducting preference test by assembling potential users of a product in one central place, may be a school, church or in a hall. The products are prepared out of sight and served on uniform plates uniquely labeled. The potential assessors then asked to taste the products and decide their level of likeness. In central location test, conditions are favorable for a high return of responses from a large sample size as the product is usually tested under conditions that are artificial in comparison to normal use at home or in parties or in restaurants (Meilgaard et al., 2007).

Laboratory tests are a technique of conducting sensory testing in a room where temperatures and light are controlled. Triangular test with blind folded taste is ideal example of this method. An advantage with this methodology is that, product preparation and presentation can be carefully controlled. Moreover, instances where there is a difference in the color of products being tested, but not one of the factors to be tested, the color of the products can be masked so that the subjects wholly concentrate on other factors (Meilgaard et al., 2007).

Home use taste is a technique in which the product is prepared and tested under its natural conditions of use at home. When two products are being evaluated, the households are given one product first, which they use for 4-7 days. Its corresponding score sheet is completed and then the second product is supplied and tasted (Meilgaard et al., 2007). Home use test is preferred to the central location test by its two main features. First, it uses natural use conditions for product assessment. Secondly, the evaluation has sufficient time to thoroughly evaluate the product rather than the first impression as the central location test. However, it is time consuming and expensive and has high possibility for unreturned responses. On other hands, family opinion may be influenced by another family decision thus information influence has to be taken into account (Ratanatriwong et al., 2006). Home use test in which response of the evaluators is given immediately after a single taste at home is said to be modified home use test.

Empirical framework

When consumers score two products, for example QPM and conventional maize, the odds ratio is the ratio of the odds of one maize variety receiving a higher score over the odds that the other maize variety receives a higher score. The odds ratio can be calculated as the anti-log of the estimated coefficient, the log odds ratio, and indicates how one product was evaluated compared to another one (Meullenet, Xiong & Findlay, 2007).

When a dependent variable is ordinal, we face a quandary. Hence, we have to use proportional odds model.

The model is: $y^* = x_i\beta+\epsilon_i$..... (1)

However, since the dependent variable is categorized, we must instead use:

$$C_x(x) = \text{Ln}\left[\frac{p(y<j)/x)}{p(y>j)/x)}\right] \quad \text{and}$$

$$= \text{Ln}\left[\frac{\sum p(event)}{1-\sum p(event)}\right] = \beta_0+\beta_1x_1+\beta_2x_2+\ldots\ldots\ldots\beta_kx_k$$

$$= \text{Ln}\left[\frac{\sum p(y<j)/x)}{1-\sum p(y>j)/x)}\right] = \alpha_j + \beta_ix_i \quad \ldots\ldots\ldots\ldots (2)$$

i = 1, 2, 3 …k

j = 1, 2, 3… p-1

Where, α_j or β_0 = thresh hold; β_1 = parameters; x_i, $_1$ = sets of factor or predictors.

Methodology of the study

Site description

Jimma zone is located 352 km away from Addis Ababa. Currently, the zone is divided in to 18 districts and one

urban administration: Jimma. Jimma town is the capital of the zone. Omo Nada *Woreda*[1], one of 18 districts of the zone, is found at 72 km away from Jimma town. The district has 39 *kebele*[2] and two urban centers. There are 47, 646 households in the district and 5.8 is the average family size. Sub-tropical, temperate and tropical agro-climates do respectively constitute 75%, 15%and 10% of the district's total size. Cereal, pulses and oil seed occupies 86.7%, 12.5% and 0.8% of the total cultivated land and maize covers 27% of total land of the district (source: Omo Nada district agriculture office, 2014 data).

Sampling procedure

A three stage sampling procedure was followed to select sample households. In the first stage, maize potential *district* has been identified in collaboration to CIMMYT staff; Omo Nada *district* was selected intentionally. In the second stage, four potential *Kebeles* were selected collaborated with concerned experts of the district's office of agriculture. Lastly, a random of rural households was identified with development agents of the respective peasant association.

For triangular test "Risk tables for discrimination tests" of Schlich P., (1993) were considered. The number of assessors for triangular test is identified based on significance level required or (α-risk), risk level (β-risk) and the proportion of assessments in which a perceptible difference is detected between the foods samples/products (p_d).

Data collection

Data for central location test was collected from 192 randomly selected assessors from four *Kebele.* The test was conducted on *Kebele* administration hall and FTC (farmers training center) hall. Farmers were requested to evaluate four types of *dabo:* white QPM, yellow QPM, white conventional and yellow conventional maize. The *dabo* was prepared out of sight and served on uniform dishes labeled the shape of "triangle", "rhombus", "square" and "circle". Neither the consumers nor the enumerators know the difference between the samples for the sake of bias. The attributes tested in the central location test were aroma, appearance, taste, hand feel, mouth feel and overall evaluation based on five and seven level hedonic scales. A 7-point hedonic scale [1=Dislike very much, 2=Dislike moderately, 3=Dislike slightly, 4=Neither like nor dislike, 5=Like slightly, 6=Like moderately, 7=Like very much] was used on two *kebeles* and a 5-point hedonic scale [1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5=like very much] was used on the rest two *kebeles.*

Data for modified home use test was collected from 210 randomly selected women who had 6-23 month children. The study was between *genfo* prepared from white QPM and white conventional maize and yellow QPM and yellow conventional maize types. Half kilograms of either of white or yellow maize varieties was provided to a woman and they prepared local food *genfo* (porridge) and feed their young children at home. The response was recorded on format prepared using scores on an ordered but arbitrary scale: a 5-point hedonic scale [1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5=like very much]. The attributes tested in the modified home use test were appearance, hand feel, mouth feel, taste, aroma and overall for mothers and only the overall of the *genfo* was evaluated by children. During the experiment, either the consumers or the enumerators had no information from which maize type the *genfo* was made from.

A triangle test is a method used to determine whether a sensory difference exists between two products (Meilgaard et al., 2007). The evaluation and the experiment was between white conventional maize and white QPM, yellow conventional maize and yellow QPM, white conventional maize and yellow conventional maize and white QPM and yellow QPM *dabos* using 16 consumers randomly selected from four *kebeles*. Each respondent was given three samples of *dabo* labeling them differently after informing them the existence of two the same samples and one different sample. Then, they were ordered to identify the odd sample from these three samples served. The respondents have been informed that they could use any method of sensory evaluation like tasting, smelling, checking the hand/mouth texture or any method that they wished to identify the odd sample blind folded or except sight.

Data analysis techniques

For all experiments data entrance and analysis were done using SPSS-20. The data from central location test and modified home use test was analyzed using descriptive statistics and paired sample t-test to compare the score of attributes of the dishes. For triangular test, the number of rightly identified odd sample was counted and the minimum number of correct responses required for significance at the stated α-risk level for the corresponding number of assessors, n, can be computed from table of critical value specifically prepared for triangular test. The assumption of "no difference" is rejected if the number of correct responses is greater than or equal to the tabled value.

[1] Medium sized administrative unit which is a group of kebeles
[2] Small administrative unit alternatively called peasant association

If the n number used did not exist on the table, we can use the following formula:

$$x = \frac{n}{3} + z\sqrt{\frac{2n}{9}} \quad \text{..... (3)}$$

Where x is the minimum number of correct response expected, n is number of assessors and z varies with the significance level (α). Accordingly, the value of z is 0.84 for α=0.20, 1.28 for α=0.10, 1.64 for α=0.05, 2.33 for α=0.01 and 3.09 for α=0.001 (Meilgaard M., Civille G.V., Carr B.T. 1991, p. 338). Alternatively, data from triangular test was also analyzed by binominal distribution. The binomial distribution is frequently used to model the number of successes in a sample of size *n* drawn with replacement from a population of size *N. T*he binomial distribution with parameters *n* and *p* is the discrete probability distribution of the number of successes in a sequence of *n* independent yes/no experiments, each of which yields success with probability *p*.

Factors affect farmers` preference of maize dishes was analyzed using ordinal logistic model which enables us to determine which of our independent variables have a statistically significant effect on our dependent variable (Long & Freese, 2006).

Result and discussion

Socio economic characteristics of respondents

Data collected from respondents of central location test shows that age of respondents ranges from 19 to 65 with a mean age of 39 years and their education composition embraces uneducated to grade ten. The average land ownership of the farmers was 1.24 hectares of which the farmers used to produce maize on 0.51 hectares (41%) of land on average. This shows that maize is prominent crop on the area by land coverage.

The descriptive result also shows that Waktola *kebele* respondents have relatively large mean age and Burka Asendabo *kebele* farmers have relatively large mean of total maize land (44%) whereas the least maize producing *kebele* was Biso Gombo (38%) relative to their total land. Waktola *kebele* farmers used to cultivate more of their total land meaning less uncultivated land (12%) and Biso Gombo respondents have more uncultivated land (34%) relatively.

Table 1: Demographic and socio economic features by *kebele*

Mean	**Peasant association**			
	Biso Gombo	**Burka Asendabo**	**Doyo Yaya**	**Waktola**
Age of respondent	39	37	35	44
Family size	7	7	6	7
Land	1.28	1.41	0.97	1.32
Cultivated land	0.84	0.99	0.72	1.15
Uncultivated land	0.44	0.41	0.25	0.16
Maize land	0.48	0.62	0.38	0.56
Net annual income in $US	260	220	269	237
N=192; 1 USD = 20.3557 ETB on March; 2015				

Source: Own computation

The socio economic characteristics of respondents of modified home use test also shows that the mean age of mothers at Doyo Yaya *kebele* were 32 years which is higher than the rest two *kebeles.* The average number of living children of mothers on the study area was four which is high on Waktola (4.58) and low on Doyo Yaya (3.54). The education level attained by mother ranges from uneducated to grade ten. The result also shows, of 210 children participated on evaluation, 56% of them were females. The mean age of children was also high on Doyo Yaya ke*bele* which was 21.4 months and lowest on Biso Gombo which was 11 months and the overall mean was 19.5 months.

Table 2: Socio-economic features of participants of modified home-use test

Description	*Kebele*						Overall mean	
	Biso Gombo		Doyo Yaya		Waktola			
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Mother's age	29.67	6.32	32.07	5.95	28.65	4.31	30.0	5.77
Child age (months)	18.27	5.66	21.4	4.61	18.43	5.71	19.5	5.54
Family size	3.7	2.09	3.54	1.73	4.58	2.18	4.0	2.06
Land holding	1.08	1.04	0.77	0.52	0.65	0.64	0.83	0.79
Maize land	0.51	0.46	0.37	0.21	0.32	0.25	0.39	0.33
Livestock	7.05	5.94	7.68	6.48	8.41	6.61	7.72	6.37

N=210

Source: Own computation

Result of triangular test

Descriptive result of the triangular test shows that 81% and 63% of women and men correctly identified the odd sample respectively showing women are good examiners than men possibly due to the experience women have as they are responsible to prepare the food for the family.

The tabled critical number for the sample size 16 is 11 (at 1% significance level). Since the number of the correctly identified odd sample for the samples, white QPM and white conventional maize *dabo,* 11 is equals the critical number (11), the assumption of "no difference" is rejected, and it is concluded that there is a significant sensory difference between *dabo* prepared from white QPM and white conventional maize. For the samples of *dabo* of yellow QPM vs. yellow conventional maize and white QPM and yellow QPM, of the 16 respondents who participated on the triangle test, 15 and 12 has correctly identified the odd samples respectively. The tabled critical number is 12 (for a significance of 0.1%). Since the number of the correctly identified odd samples 12 and 15 are greater than or equals to the critical number (12), the assumption of "no difference" is rejected. Thus, there is a significant sensory difference between yellow QPM vs. yellow conventional maize *dabo* and white QPM and yellow QPM *dabo.* For the last sample particularly between yellow conventional maize vs. white conventional maize, only half of the whole respondents identified the odd sample. Since the number of correctly identified odds 8 is less than 11 of the critical number, we did not reject the null hypothesis and thus, there is no statistical evidence to conclude the two maize *dabo* is different **(See table 3 below).**

Table 3: Triangular test result

Samples	Number of respondents	Correct response	Incorrect response	P-value
White QPM vs. white CM	16	11	5	0.004*
White QPM vs. yellow QPM	16	12	4	0.001*
Yellow QPM vs. yellow CM	16	15	1	0.000***
White CM vs. yellow CM	16	8	8	0.127

N=16

*****=Statistically significant at 0.1%; **=Statistically significant at 0.5%; *=Statistically significant at 1%**

Source: Own computation

Result of central location test

The paired sample t-test result from central location test shows that the mean scores of white QPM *dabo* was consistently higher than the two conventional maize *dabo* for all attributes except in appearance which suggests that QPM *dabo* was more appreciated than the conventional maize *dabo*. Accordingly, the highest mean difference was seen on texture in hand (0.75) and on taste (0.81) for 5 point likert scale and 7 point likert scales respectively.

Table 4: Mean score of *dabo* prepared from white QPM and white CM

Attributes	5-point likert scale mean score			7-point likert scale mean score		
	White QPM	White CM	P-value	White QPM	White CM	P-value
Appearance	4.30	4.27	0.72	6.09	6.00	0.451
Texture in hand	4.19	3.61	0.000***	5.96	5.29	0.000***
Aroma	4.20	3.57	0.000***	5.94	5.17	0.000***
Texture in mouth	4.17	3.56	0.000***	5.85	5.06	0.000***
Taste	4.17	3.56	0.000***	5.85	5.04	0.000***
Overall	4.19	3.58	0.000***	5.93	5.13	0.000***
N=96				**N=96**		
Meaning of scores: Dislike very much(1) to Like very much(5)				**Meaning of scares: Dislike very much(1) to Like very much(7)**		

***** = Statistically significant at 0.1%; ** = Statistically significant at 0.5%; * = Statistically significant at 1%**

Source: Own computation

The experiment also investigated that yellow QPM *dabo* was more appreciated than *dabo* of yellow CM. For the samples, the high mean difference was seen on the appearance (0.96) and on overall of *dabo* (1.23) on 5 and 7 point likert scales respectively.

Table 5: Mean score of *dabo* prepared from yellow QPM and yellow CM

Attributes	5-point likert scale mean score			7-point likert scale mean score		
	Yellow QPM	Yellow CM	P-value	Yellow QPM	Yellow CM	P-value
Appearance	4.71	3.75	0.000***	6.54	5.44	0.000***
Texture in hand	4.60	3.73	0.000***	6.40	5.35	0.000***
Aroma	4.53	3.67	0.000***	6.30	5.22	0.000***
Texture in mouth	4.57	3.67	0.000***	6.24	5.19	0.000***
Taste	4.55	3.71	0.000***	6.26	5.11	0.000***
Overall	4.58	3.74	0.000***	6.31	5.19	0.000***
N=96				**N=96**		
Meaning of scores: Dislike very much(1) to Like very much(5)				**Meaning of scares: Dislike very much(1) to Like very much(7)**		

***** = Statistically significant at 0.1%; ** = Statistically significant at 0.5%; * = Statistically significant at 1%**

Source: Own computation

The descriptive result also shows that about 7% and 5% of consumers were disliked overall sensory property of white conventional and yellow conventional maize *dabo* respectively and more than 52% of respondents liked overall property of white QPM *dabo* while 15% neither liked nor disliked it. About 62% of farmers gave the score "like very much" for the overall attribute of yellow QPM *dabo* and only 3% neither liked nor disliked. The overall sensory property of white conventional maize *dabo* scored more "neither like nor dislike" (30%) relatively and only 3% of consumers liked it very much.

To summarize the inferential and descriptive results of central location test, QPM based *dabo* was more appreciated in all sensory attributes except for appearance than conventional maize based *dabo* using both five and seven point likert scales. Particularly, yellow QPM *dabo* was more appreciated than white QPM *dabo* in all sensory attributes while no significant difference between white and yellow conventional *dabo* except for appearance. The appearance of white conventional maize *dabo* was more appreciated than the yellow conventional maize at 1% significance level.

Modified home use test

The descriptive sensory result during modified home-use test shows that more "like very much" by mothers were rated for yellow QPM *genfo* (82%) and the lowest "like very much" were for yellow conventional (4%) *genfo*. White QPM *genfo* rated "like very much" by 46% of mothers while about 2% of mothers disliked white conventional maize *genfo* and 1% disliked white QPM *genfo*. However, no any type of *genfo* rated "dislike very much" by both mothers and children. Children rating was also the same as mothers rating with only different magnitude. Accordingly, yellow QPM and white QPM *genfo* rated "like very much" by 59% and 45% of child while 67% and 51% of child rated "like" for white and yellow conventional maize *genfo* respectively.

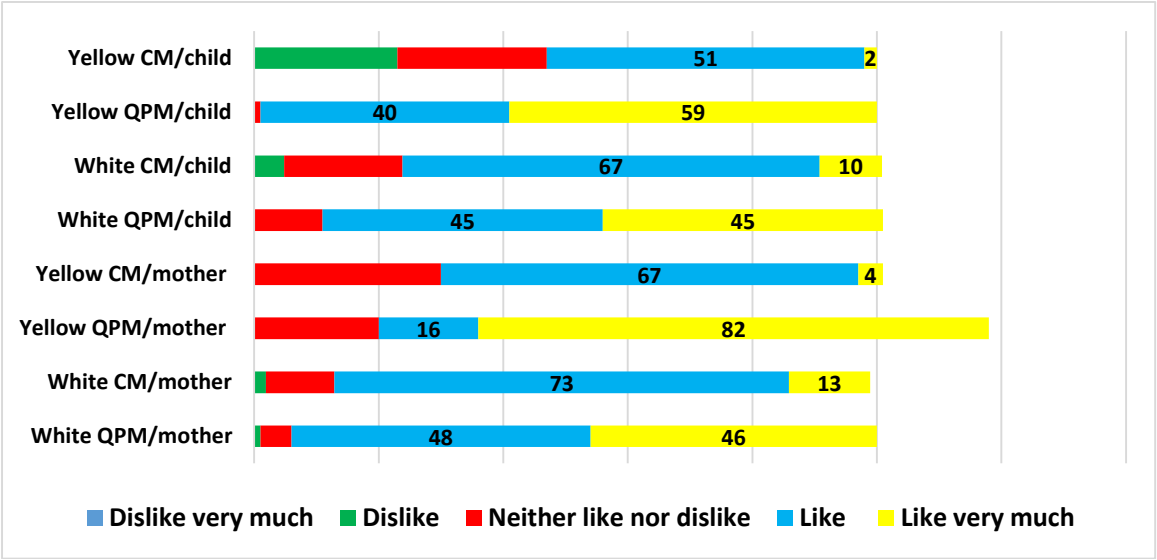

Figure 1: Overall rating of mother and child during modified home use test in %

The detail score of attributes given for the *genfo* shows the highest mean score for white QPM *genfo* given by mothers was taste (4.41) and the highest mean score for white conventional maize *genfo* given by mothers was appearance (4.26). The lowest mean score for white QPM *genfo* was seen on texture in hand (4.31) and on taste (3.97) for the white conventional maize *genfo*. The children overall evaluation of the *genfos* also shows that the score given was 4.34 and 3.81 for white QPM and white conventional maize *genfo* respectively **(see the summary below).**

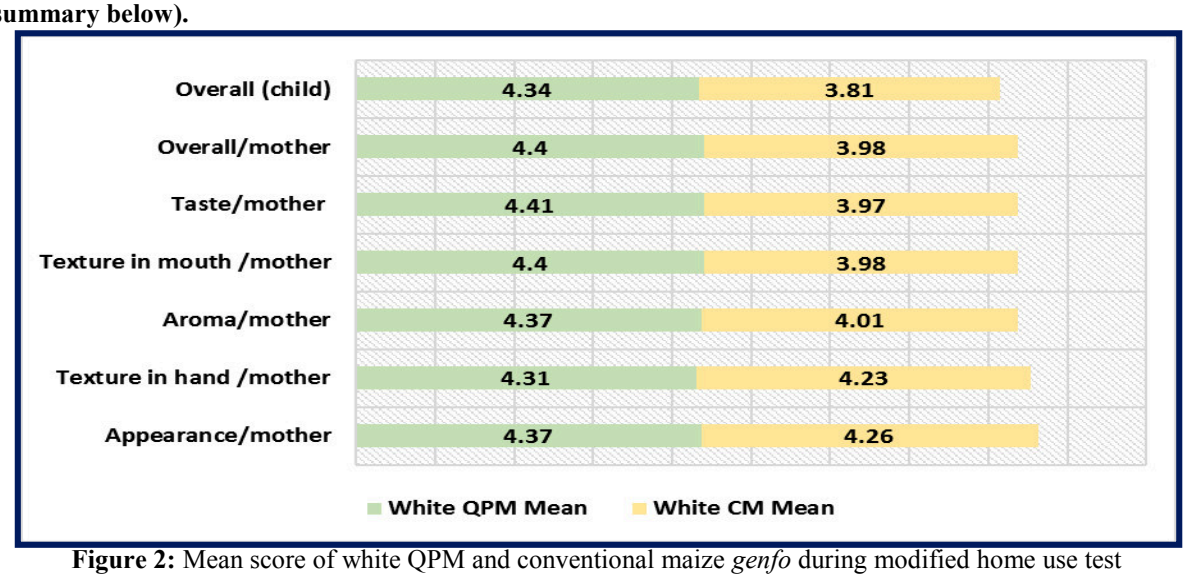

Figure 2: Mean score of white QPM and conventional maize *genfo* during modified home use test

Concomitantly, the highest mean score for both yellow QPM *genfo* and yellow conventional *genfo* were seen on overall attribute which are 4.80 and 3.74 respectively. The lowest mean score of yellow QPM *genfo* was seen on the texture in hand (4.63) and on aroma for yellow conventional maize *genfo* (3.68) during mother's evaluation. The children gave the score 3.32 and 4.58 for yellow conventional and yellow QPM *genfos* respectively (see summary below).

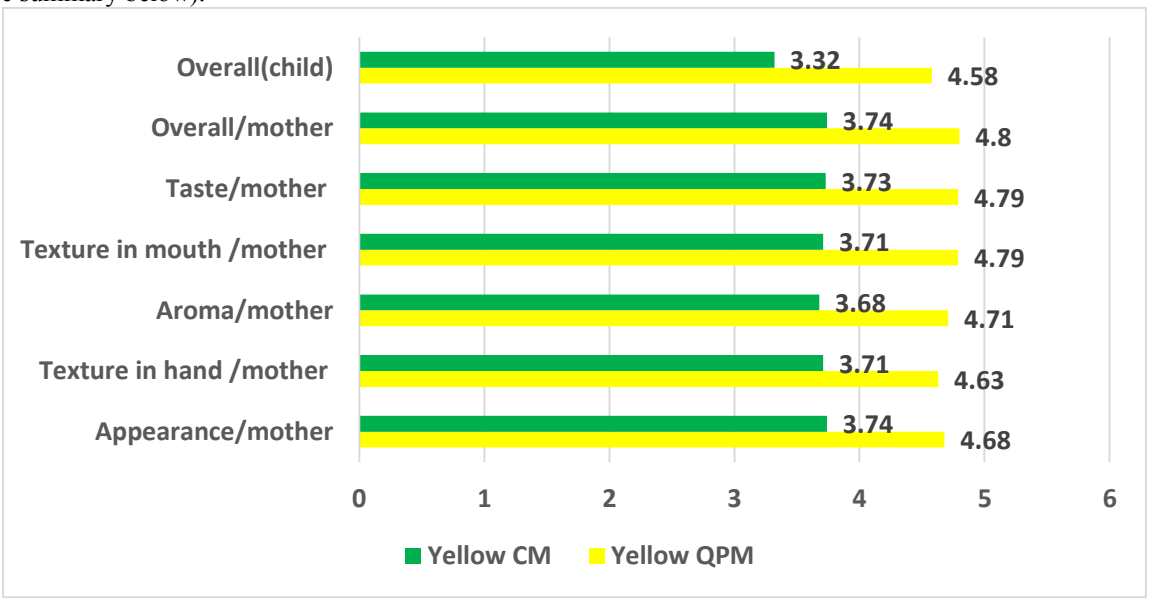

Figure 3: Mean score for yellow QPM and yellow CM *genfo* during modified home-use test

To conclude the sensory evaluation test between QPM and conventional maize *genfo* at home explored that g*enfo* of the white QPM is more appreciated than the white conventional one in terms of aroma, texture in mouth, taste and overall while no significant difference in appearance and texture in hand which is expected because similarity of the two varieties especially in color. More interestingly, *genfo* prepared from yellow QPM is highly appreciated in all attributes by mothers and child than the conventional counterpart. They were asked the reason why they appreciated and most of them responded as it is simply detached from cooking pot and its good appearance and aroma.

The result of the study conducted in southern Ethiopia shows that QPM-based porridge was scored higher for its texture in the hand and mouth, while its scores for appearance, aroma, and taste were not statistically

different from those of porridge made from conventional maize. Overall acceptance of the two varieties by both mothers and children was also not significantly different (Gunaratna et al., 2015). The finding is consistent with the study conducted in Tanzania on stiff porridge of white QPM and white conventional maize varieties where QPM stiff porridge had collected significantly higher scores ($p<0.01$) in terms of the overall sensory profile, aroma, taste and mouth than conventional maize stiff porridge. However, there was no difference between appearance of QPM stiff porridge and conventional maize stiff porridge (Kiria, 2010). Ouma et al (2006) also found that overall QPM based "g*itheri"* was more preferred than conventional *githeri* in taste and texture than the control. However, on appearance, QPM based preparation was perceived to be equal to the control. On another study, QPM *ugali* was generally preferred over its conventional counterpart in the overall evaluation it received, and it also scored better for all criteria except appearance (De Groote et. al., 2014).

Nexus between overall score and other sensory attributes

The study also tried to explore which attribute specially affects mothers' overall score during modified home-use test using linear regression model. The result shows with their large coefficient, taste and texture in mouth highly affect mothers' overall ratings than any of other attributes though others are also influential except aroma and texture in hand.

Table 6: Relation between overall score and other sensory attributes (linear regression result)

Sensory attributes	Coefficient	Std. Error	Sign.
(Constant)	0.076	0.061	0.216
Appearance	0.066	0.024	0.006*
Texture in hand	0.067	0.029	0.020
Aroma	0.038	0.032	0.234
Texture in mouth	0.200	0.042	0.000***
Taste	0.614	0.041	0.000***

***** = Statistically significant at 0.1%; ** = Statistically significant at 0.5%; * = Statistically significant at 1%**

$R^2 = 0.926$

Source: Own computation

On similar study conducted in three east African countries: Tanzania, Kenya and Ethiopia, different sensory characteristics of foods affect the overall rating of the food in different manner and magnitude based on the dishes and cultural preference. Taste was the biggest contributor to acceptance in Tanzania and Ethiopia. In Kenya texture and appearance were more important (De Groote et al., 2014). On another study in southern Ethiopia, mothers` overall scores were positively related to acceptability of aroma and taste (Gunaratna et al., 2015).

Determinants of sensory preference of maize dishes

Ordinal regression model was used to analyze factors related to sensory appreciation using main effect, cross affect and color effect. The main effect result showed that QPM *genfo* was evaluated better than the conventional maize. The log odds ratio of QPM *genfo* was 2.76, which was translated to an odds ratio of approximately 16 (16:1) when the exponent was taken. The result implied QPM *genfo* were appreciated by rural consumers sixteen (16) times more than the *genfo* of conventional maize which is consistent with the descriptive result. This finding is also in line with the findings on literature of Ouma et al., (2006), Kiria, (2010), and De Groote et al., (2010). Total livestock ownership by the consumers affect the sensory preference negatively (0.96=odds ratio) which corroborate with Kiria, (2010) finding while total income have positive and significant coefficient (1=odds ratio). Doyo Yaya *kebele* gave high score and Biso Gombo *kebele* gave low score for *genfo* during evaluation for respective positive and negative coefficients. The other factor seen to affect score of the samples was order of the samples during evaluation. Accordingly, it has positive coefficient (0.742) meaning being first order increased the likelihood of collecting the better score by 2.1 times (exponent of 0.742). The result concurs with the study conducted in Ethiopia where acceptance scores was significantly higher in the first round than in the second and illustrates the importance of presenting food samples in random order (De Groote et al., 2014). On another study Morawetz et.al., (2011) found the individual dummy for plain yellow meal presented before fortified white was significant at the 10% level. Gunaratna et al., (2015) also found that for all sensory characteristics, the variety that was evaluated first received significantly higher scores.

The cross effect result shows that age has positive relation to QPM *genfo* preference which might be resulted from cooking and tasting experience and is consistent with the study conducted in Tanzania and Ethiopia (Kiria, 2010; Gunaratna et al., 2015). Similarly, highest education level attained and income have positive coefficients meaning as education level and income increases appreciation of QPM *genfo* increases while livestock ownership have negative coefficient on cross effect too. The cross effect result also shows that Doyo Yaya *kebele*

appreciated QPM *genfo* highly and Biso Gombo *kebele* gave low score for QPM *genfo* during modified home use test with an odds ratio of 1.57 and 0.41 respectively which concurs the finding on the descriptive result. On other hand, order has positive impact on QPM *genfo* score by increasing the score rate by 1.6 (exponent of 0.464). Descriptive result of home use test and central location test revealed yellow QPM *genfo* were more appreciated than white QPM *genfo*. The cross effect result also confirmed that white QPM *genfo* were given less score than the yellow QPM *genfo* with negative coefficient of the white (0.17=odds ratio).

It has also been tried to investigate what factors drive to the preference of color using color effect. The result shows yellow QPM *genfo* were more appreciated by consumers with the coefficient of white QPM *genfo* -0.324(odds ratio=0.72) which means white maize *genfo* were appreciated but not as high as the yellow *genfo*. The results were consistent with the result seen on the paired wise test. On other hands, age was positively and significantly related to yellow QPM *genfo* preference. High age group liked the yellow QPM *genfo* than the white QPM *genfo* for the positive coefficient of yellow QPM *genfo* (0.149) **(See appendix - I)**

Main effect result of ordinal regression of overall score of the children also shows that positive relation between child overall score and mothers` overall score with a coefficient of 0.892 (2.44=odds ratio) which corroborates with the finding in Ethiopia (Gunaratna et al., 2015). The finding states that children`s overall scores were related to their mother's score on appearance. Age of children positively and significantly affect the preference of maize varieties and male children gave high overall score for *genfo* evaluated. Sample order was also a factor considered to affect sensory score given to the *genfo*. Accordingly, being first sample increases the likelihood of scored better (1.59=odds ratio). Doyo Yaya children appreciated the sample *genfo* highly and significantly and QPM *genfo* has been appreciated than the conventional maize more than eight times (exponent of 2.11) while white maize *genfo* was less appreciated than the yellow QPM 0.755 times (exponent of -0.28).

The cross effects also show that mothers overall score affect the preference of QPM *genfo* positively and age of the children also positively related to QPM preference as its coefficient is positive (0.05). Being first order has positive impact on score given to QPM *genfo* with 1.40 odds ratio and white QPM *genfo* were appreciated less than the yellow counterpart for its negative coefficient (-0.721). Doyo Yaya *kebele children* appreciated the yellow QPM *genfo* relative to other *kebeles*. The color effect result also shows that yellow QPM *genfo* was appreciated on both Doyo Yaya and Biso Gombo *kebeles* significantly with an odds ratio of 1.41 and 10.29 respectively. **(See appendix - II)**

Conclusions and policy recommendation

The aim of the study was to explore the sensory difference and acceptance exists between QPM and conventional maize traditional dishes using the triangular test, central location test and modified home use test. The result of triangular test shows the existence of statistically significant sensory difference between *dabo* made of white QPM and white conventional maize; and yellow QPM and yellow conventional maize. However, there was no clear and significant sensory difference between *dabo* prepared from two conventional maize grains. The result of central location test also shows the mean scores of *dabo* prepared from white QPM was consistently higher than that of white conventional maize in all attributes except for appearance. Similarly, *dabo* from yellow QPM was significantly appreciated than the yellow conventional, white QPM and white conventional maize based *dabo* almost in all attributes. The result of modified home-use test also revealed that the mean score of g*enfo* prepared from white QPM was significantly higher than the white conventional one in terms of texture in mouth, aroma, taste, and overall. However, no significant differences in appearance and texture in hand as similarity in color of the grain between white QPM and white conventional maize *genfo*. On other hands, *genfo* from yellow QPM were highly and significantly appreciated than the yellow conventional maize counterpart in all attributes. Alike mothers, children evaluation of *genfo* made of QPM and conventional maize shows that children`s mean overall score for both color QPM was significantly higher than both color conventional maize *genfo*.

The results suggested that QPM based dish is different from that of the conventional maize dishes at least in one sensory characteristic. This sensory characteristic that differ QPM dish from the conventional maize dish during triangular test drove QPM dish to be appreciated and liked by consumers during central location test and modified home-use test. Thus researchers, extensionists and organizations working in the area of food security and poverty reduction should use this sensory acceptability of QPM to disseminate and diffuse the technology. This encourages production and consumption of QPM among rural households and finally tackles malnutrition.

Another interesting result from both central location test and modified home-use test shows that the mean score of yellow QPM based dish was significantly higher than both white QPM and yellow conventional maize based traditional dishes. Thus, researchers and extensionists should emphasize on yellow QPM aside the white one due to its good sensory acceptance.

The order of sample presentation had significant impact on sensory evaluation during the experiments. Thus, great care and attention should be given for the randomization of the samples.

To sum up, consumers` sensory acceptance is the main tool for the adoption and penetrating mechanism of new food related agricultural technologies. The researchers have identified two general issues from the study:

consumers` sensory characteristics and socio economic and demographic factors related to their sensory preference. Moreover, the study investigated the consistency of the research methodologies used on the study to achieve the research objectives.

Future direction

Due to time constraint, the study was limited to one district and four peasant associations with satisfactory sample size. However, one district is too few and cannot represent the rest of maize potential areas of the country since large socio cultural diversity and difference among regions and zones. Thus, the study should be extended to other maize producing areas of the country.

The study used both five and seven level hedonic scales and most of respondents were illiterates specially women. They were struggled to understand the complexity of seven level hedonic scales. Thus, it is more preferable to use the five likert scale for illiterates especially for rural community.

The target group used on modified home-use test experiment was women and children aged 6-23 months. However, it was difficult for the child to identify sensory preference especially when age of children is below 12 months. So, modification should be made for future studies on the lower limit of the age of children for the reliability of the data since mothers were sometimes responding their own feelings simply by themselves during the evaluation when the child does not respond and faced difficulty while reading her child's facial satisfaction or dissatisfaction.

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APPENDIX

Appendix - I: Ordinal regression model result for mothers overall rating during MHUT

Variables		Estimates	Standard error	Significance
Threshold	[Mother overall score = 2.00]	-4.374	0.387	0.000
	[Mother overall score = 3.00]	-1.242	0.215	0.000
	[Mother overall score= 4.00]	2.293	0.229	0.000
Main effect	Mother education	0.022	0.023	0.341
	Number of living children	-0.049	0.032	0.129
	Total livestock	-0.040	0.010	0.000***
	Total income	0.000	0.000	0.000***
	[kebele=Biso Gombo]	-0.493	0.146	0.001***
	[kebele=Doyo Yaya]	0.296	0.158	0.061*
	[maize type =QPM]	2.762	0.148	0.000***
	[maize color=white]	-0.324	0.120	0.007***
	[sample order= first]	0.742	0.122	0.000***
Cross effects	QPM * mother age	0.029	0.017	0.092*
	QPM * mother education	0.071	0.037	0.051*
	QPM * total livestock	-0.058	0.015	0.000***
	QPM * total income	0.000	0.000	0.008*
	QPM * [sample order =first]	0.464	0.189	0.014**
	QPM * [kebele=Biso Gombo]	-0.896	0.221	0.000***
	QPM * [kebele=Doyo Yaya]	0.452	0.253	0.074*
	QPM * [color=white]	-1.751	0.197	0.000***
Color preference	yellow QPM * mother age	0.149	0.036	0.000***
	Yellow QPM * total maize land	1.562	0.985	0.113

Model Pseudo R^2 (Naglekerke) = 48.7
Pearson-chi-square = 5110.74 ***
N = 210

***** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%**

Source: *Own computation*

Appendix - II: Ordinal regression result during modified home use test for children

Variable		Estimate	Standard error	Significance
Threshold	[Child overall score= 2.00]	2.410	0.467	0.000
	[Child overall score= 3.00]	3.823	0.470	0.000
	[Child overall score= 4.00]	7.225	0.511	0.000
Main effect	Mother overall score	0.892	0.104	0.000***
	Child age	0.036	0.011	0.001***
	[kebele=Biso Gombo]	-0.026	0.138	0.852
	[kebele=Doyo Yaya]	0.254	0.143	0.076*
	[child sex=male]	-0.273	0.116	0.018**
	[maize color=white]	-0.280	0.115	0.016**
	[maize type =QPM]	2.111	0.160	0.000***
	[sample order=first]	0.461	0.116	0.000***
Cross effects	QPM * Mother overall	0.363	0.158	0.022**
	QPM * Child age	0.050	0.016	0.001**
	QPM * [kebele=Biso Gombo]	0.033	0.198	0.867
	QPM * [kebele=Doyo Yaya]	1.167	0.217	0.000***
	QPM * [child sex=male]	-0.280	0.170	0.100
	QPM * [maize color=white]	-0.721	0.185	0.000***
	QPM * [sample order = first]	0.339	0.170	0.046**
Color preference	Yellow QPM * mother overall score	0.282	0.298	0.345
	Yellow QPM * [order=first]	0.505	0.285	0.076*
	Yellow QPM * [kebele= Biso Gombo]	2.233	0.343	0.000***
	Yellow QPM * [kebele=Doyo Yaya]	2.331	0.367	0.000***

Model **Pseudo R^2 (Naglekerke) = 44.1**
Pearson-chi-square 2616.833 ***
N= 210

***** = statistically significant at 1%; ** = statistically significant at 5% ;* =statistically significant at 10%**

Source: *Own computation*