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Evaluation of Quality Protein Maize Traditional Dish at Home and Consumers` Willingness to Pay for its Grain in Jimma Zone: Omo Nada District

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Abstract
Background and methodology: The objective of the study was to identify consumer's sensory preference of quality protein maize and conventional maize traditional dishes and then try to estimate the willingness to pay for quality protein maize grain in Jimma Zone. It used modified home-use test sensory evaluation technique and Becker-De Groote- Marschak experimental auction mechanism. The data was collected from 210 mothers and children aged 6-23 months. All mothers participated on modified home-use test was participated on experimental auction. SPSS-20 was used for for descriptive statistics and ordinal logistic regression and Stata 12.1 was used for random effect model to explore factors related to willingness to pay. **Result:** The result from modified home-use test explored quality protein maize genfo was appreciated by all sensory attributes than conventional maize genfo particularly high appreciation for the yellow quality protein maize genfo. The overall score of children also realized that quality protein maize genfo was significantly appreciated than the conventional counterpart. The experimental auction result revealed that sample respondents were willing to pay more for quality protein maize grain and the main driving factor was its sensory quality. The result also shows information has boosted bids of white and yellow quality protein maize grain. **Recommendation:** The study finally recommends concerning bodies to use sensory superiority and market potential of quality protein maize for its adoption, dissemination, processing in food industries, marketing and then consumption among farmers in rural areas as quality protein maize is recognized as a tool to tackle protein malnutrition.
Keywords: Willingness to pay, modified home-use test, Becker-De Groote- Marschak mechanism, ordinal logistic regression, random effect model.

Background and justification of the study

Food insecurity and per capita calorie consumption in the world has not registered significant improvement in recent years though production and productivity of agricultural produces is increasing. Consequently malnutrition, specific nutrient deficiencies and anemia primarily causes immune deficiency and then finally increased the risk of maternal morbidity and mortality (Domellof, 2011). The intention and capability of rural population towards regularly feeding the family with disease preventing and body building foods such as vegetables, fruits and animal products as well as supplementation of food to children as an addition to breast milk is very poor (MoH, 2003). Hence, the adoption and diffusion of staple crops based bio fortified commodities such as quality protein maize may be regarded as a good option for rural smallholder farmers (De Groote et al., 2010).

The study is aimed to identify consumers' sensory preference and acceptance for QPM and the conventional maize based traditional dishes and tries to estimate the willingness to pay for QPM grain in Omo Nada district and the specific objectives of the study are:

- ✓ To evaluate consumers` sensory preference for QPM and conventional maize *genfo*.
- ✓ To estimate consumers` willingness to pay for QPM and conventional maize grains.
- ✓ To investigate determinants of consumers` sensory preference of maize dishes and factors affect the willingness to pay for the grains.

The rest of this paper is organized under four sections. Section two embraces key concepts like QPM, sensory evaluation, willingness to pay and empirical framework. Section three discussed data collection and data analysis methods used in the study. Section four focuses on discussion of results from experiments and section five summarizes the study and presents conclusions, limitations and policy recommendations.

Review of literature: Sensory evaluation and willingness to pay

Despite its poor nutritional value particularly low in the limiting amino acids: tryptophan and lysine (Truswell and Brock, 1962), maize is a prominent staple food especially in Eastern and Southern Africa. To overcome these shortcomings, it should be consumed with protein enriched foods such as meat, milk and beans which are relatively expensive. This drove scientists to search alternative ways to increase lysine and tryptophan content (Vasal et al., 1980) for those who daily and regularly produce and consume it and then tackle malnutrition and

improve growth and health, particularly in young children (Lauderdale, 2000). Efforts by breeders at the international maize and wheat improvement center (CIMMYT) finally yielded varieties with high lysine and tryptophan contents (Vasal, 2000) and proved to have positive results towards malnutrition. For the farmers to adopt the food based technologies, it is essential to investigate sensory quality and market potential of those commodities using sensory evaluation and experimental auction techniques.

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). Based on the environment in which assessment is conducted, there are three methods of sensory evaluation techniques: laboratory tests (e.g. triangular test), central location tests and 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 (Meilgaard et al., 2007).

Laboratory tests are a technique of conducting sensory testing in a room where temperatures and light are controlled. Color and other visual aspects are fully under control and thus subjects concentrate on the differences in flavor or texture or other attributes. Triangular test with blind folded taste is an example of this method (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 four to seven days. Its corresponding score sheet is completed then the second product is supplied and tasted (Meilgaard et al., 2007). Home use test is preferred way of sensory assessment, since it uses natural use conditions for product assessment and the evaluation has sufficient time to thoroughly evaluate the product rather than the first impression. However, home use test is time consuming and expensive and has high possibility for unreturned responses. In addition, the family opinion may be influenced by another family decision thus information influence has to be taken into account in home use test (Ratanatriwong et al., 2006). Home use test in which response of the evaluators is given immediately after single taste at home is said to be modified home use test.

Economists, psychologists and marketers are interested in determining the monetary value of non-market goods to carry out cost-benefit analysis, to determine the welfare effects of technological innovation or public policy, to forecast new product success, and to understand individual and consumer behavior (Lusk and Shogren, 2007:1). Willingness to pay (WTP) is defined as the maximum price a buyer accepts to pay for a given quantity of goods or services (Wertenbroch and Skiera, 2002). Elicitation of WTP is carried out for products in which a market does not yet exist and it is an indicator of the value or quality of the commodity and a determinant of the incentives for product innovation. Researchers use different auction mechanisms to elicit WTP based on their product and their goal set. Among them English auctions, Vickrey or second price auction, random n^{th} price auction and BDM are theoretically incentive compatible auctions (Lusk et al., 2004:391). An auction mechanism is considered theoretically incentive compatible if an individual's dominant strategy is to bid in such a manner that valuations are truthfully revealed.

Becker-De Groote-Marschak (BDM) Lotteries is an auction mechanism in which bidders submits an offer price to purchase a product simultaneously. Each participant sets a maximum price for the product offered. A randomly drawn price from a distribution of prices will be a selling price in this mechanism. The possible prices cover an interval from zero to a price greater than the anticipated maximum price, which any bidder would submit. The bidders whose bids are greater than the sale price receive a unit of the good and pay an amount equal to the sale price; otherwise the participant cannot buy the product (Becker, De Groote & Marschak, 1964:227). Two things differs BDM mechanism from other incentive compatible methods. First: a participant bid is compared to the randomly generated number rather than with one another (Becker et al., 1964: 228). Second: although BDM auction in groups are possible, the BDM approach can be executed individually, which may be more convenient for researchers (Monchuk et al., 2007:96).

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:

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

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

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

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

The study site

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).

Data collection

Data for modified home use test was collected from 210 randomly selected women who have 6-23 month children. The study was between *genfo* prepared from white QPM and white conventional maize and yellow QPM and yellow conventional maize varieties. Half kilograms of either of white or yellow maize varieties was provided to a women 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 overall for children. During the experiment, either the consumers or the enumerators had no any information from which maize type the *genfo* was made from.

Data collection for experimental auction was combined with modified home use test so that each consumer participated on modified home-use test was asked to elicit his/her willingness to pay using BDM auction mechanism. The auction was conducted in three ways with equal distribution of participants: auction without QPM nutritional information, auction after QPM nutritional information, and before and after provision of QPM nutritional information. To help the farmers understand the BDM procedure, a test round (practice round) with biscuits was first organized. After test round, bidders were intentionally given enough money for the actual auction to tackle cash-in-hand effect and then presented with a kilogram or four *tasa*[3] of two types of maize grain. The grain has been provided on the front of the codded respective meals in alternate order to avoid selection bias. Finally respondents were asked to make a bid for the first product, which was recorded, and the procedure was repeated for the rest of product. To reduce the auction costs and to avoid the effects of reduced marginal utility of maize grain, only one of the auctions, randomly selected at the end, was made binding and executed. The bid of the binding product was compared to a number randomly drawn from a normal distribution with mean ETB 4[4]. If the respondent's bid was higher than the random number, the bidder win and the purchase took place at drawn number.

Data analysis techniques

Data entrance and analysis were done using SPSS-20. Descriptive statistics and paired sample t-test were employed to compare the scores of each varieties and bids of the auction. Factors affect farmers` preference of maize dishes was analyzed using ordinal logistic model. Ordinal logistic regression is used to predict an ordinal dependent variable given one or more independent variables. It enables us to determine which of our

[1] Medium sized administrative unit which is a group of kebeles
[2] Small administrative unit alternatively called peasant association
[3] Local measurement of grain approximately equals to 250 gm.
[4] Local market price of four *tasa* of maize grain on march 2015

independent variables have a statistically significant effect on our dependent variable (Long & Freese, 2006). Farmers' willingness to pay(y) differs among products, income group, consumers, location and knowledge of QPM nutritional importance. Random effects model was run using STATA 12.1 to determine factors affect WTP. The following model summarizes the effect of those variables on willingness to pay for **i** consumers and **j** product with their own disturbance terms, $\mathbf{u_i}$ and $\mathbf{v_i}$ respectively.

$$y_{ij} = \alpha + \alpha' x_j + \beta' f_i + \gamma' d_i + \rho' z_j + x'_j Af_i + x'_j Bd_i + x'_j Cz_j + d'_j Dz_j + \mu_i + \nu_{ij} \quad .....(3)$$

Where: Vector *fi* of K to include consumers characteristics like gender, age, sex, years of formal education, vector d_i to include location effect, vector z_i to include QPM nutrition information effect, Matrix A to include cross effects of income on WTP for different products, matrix B to include cross effects of location on WTP for different products, matrix C to include cross effects nutritional information on WTP for different products, matrix D to include cross effects of information on consumers` WTP for different location characteristics (De Groote et al., 2010).

Result and discussion

Characteristics of survey households

The descriptive result of the study shows that the mean age of mothers at Doyo Yaya *kebele* was 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 result also shows, of 210 children participated on evaluation, 55.7% of them were females. The mean age of children was 19.5 months **(See table 1).**

Table 1: Socio-economic features of participants

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's age in months	18.27	5.66	21.4	4.61	18.43	5.71	19.5	5.54
Number of living children	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; March: 2015

Research result from modified home-use test

The overall rating within a varieties shows that more "like very much" by mothers were rated for yellow QPM *genfo* (81.9%) and the lowest "like very much" were for yellow conventional (3.8%) *genfo*. White QPM *genfo* rated "like very much" by 46.3% of mothers while about 1.9% of mothers disliked white CM *genfo* and 1% disliked white QPM *genfo*. However, no any type of *genfo* rated "dislike very much" by both mothers and children. Children rating also shows 59% and 44.8% rated "like very much" for yellow QPM and white QPM *genfo w*hile 66.7% and 51.4% of children rated "like" for white and yellow CM *genfo* respectively.

Table 2: Overall rating of mother and child during modified home use test in %

Sample type	Dislike very much	dislike	Neither like nor dislike	Like	Like very much
White QPM/mother	0	1	4.8	47.6	46.3
White CM/mother	0	1.9	11.4	73.3	13.3
Yellow QPM/mother	0	0	1.9	16.2	81.9
Yellow CM/mother	0	0	29.5	66.7	3.8
White QPM/children	0	0	10.5	44.8	44.8
White CM/children	0	4.8	19.0	66.7	9.5
Yellow QPM/children	0	0	1	40.0	59.0
Yellow CM/children	0	22.9	23.8	51.4	1.9
N=210					

Source: *Own computation*; March: 2015

The detail score by 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).

Table 3: Paired sample t-test result between white QPM and white CM *genfo*

Attributes	White QPM		White CM			P-value
	Mean	S.D	Mean	S.D	t	
Appearance/mother	4.37	0.59	4.26	0.63	3.16	0.158
Texture in hand /mother	4.31	0.63	4.23	0.58	3.61	0.223
Aroma/mother	4.37	0.64	4.00	0.57	4.27	0.000***
Texture in mouth /mother	4.40	0.63	3.98	0.61	4.91	0.000***
Taste/mother	4.41	0.65	3.97	0.59	5.02	0.000***
Overall/mother	4.40	0.63	3.98	0.57	4.91	0.000***
Overall (child)	4.34	0.66	3.81	0.66	5.74	0.000***
N=210						

Source: Own computation; March: 2015

Inferential statistics shown above explored there was a significant mean difference between white QPM and white conventional maize *genfo* in overall score of children and aroma, texture in mouth, taste and overall attributes of mother during modified home use test. However, there was no statistical evidence to conclude that appearance and texture in hand of two maize varieties *genfo* are different.

The highest mean score of both yellow QPM *genfo* and yellow conventional *genfo* was seen on overall attribute which is 4.80 and 3.74 respectively. The result also shows that there was significant score difference between yellow QPM and yellow conventional maize *genfo* evaluated by mothers and child in all attributes.

The result of the study conducted in southern Ethiopia shows QPM-based porridge scored higher for texture in the hand and mouth, while its scores for appearance, aroma, and taste were not statistically different from that of the porridge made from conventional maize. The overall acceptance of the two varieties by both mothers and children was also not significantly different (Gunaratna et al., 2015). 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 score of QPM and control was perceived to be equal. On another study, QPM *ugali* was generally preferred over its CM counterpart for all criteria except appearance (De Groote et. al., 2014).

Interaction between overall score and other attributes

The study also tried to identify which attribute specially affects mothers` overall score during modified home-use test. The result shows all attributes are significantly related to overall score of the *genfo except a*roma and texture in hand. However, taste highly affected mothers` overall ratings than any of other attributes as relatively large coefficient on the attribute. All evaluated sensory characteristics contributed to the overall evaluation except for aroma and appearance of *ugali* in Tanzania. 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).

Table 4: Relation between overall score and other sensory attributes

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; March: 2015

Factors affect sensory preference of QPM 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* was appreciated by rural consumers sixteen (16) times more than the *genfo* of CM which is consistent with the descriptive result. This finding is also in line with 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), 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. On other hands, order of the samples 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 (De Groote et al., 2014). 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 respondents` 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 revealed that 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).

Another result shows yellow QPM *genfo* was more appreciated by consumers with the coefficient of white QPM *genfo* -0.324(odds ratio=0.72) which means white maize *genfo* was 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 model 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). Age of children positively and significantly affect the preference of maize varieties. Child with relatively large age appreciated the *genfo* prepared by 1.03 times when the exponent was taken 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 order increased 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* has been less appreciated than the yellow QPM 0.755 times (exponent of -0.28).

The cross effects also shows 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) meaning age increases QPM *genfo* appreciation by 1.05 times. 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* appreciated the yellow QPM *genfo* relative to other *kebeles*.

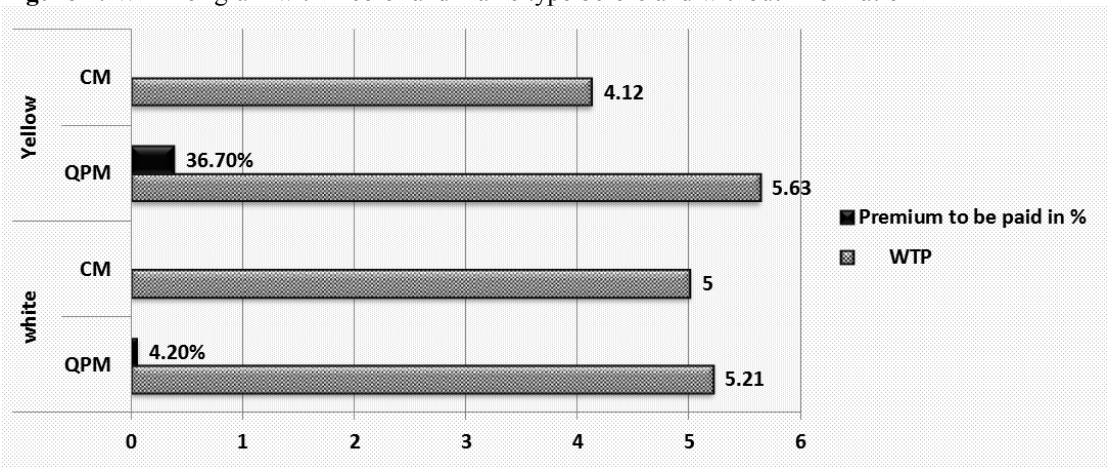
The color effect result also shows that yellow QPM *genfo* were appreciated on both Doyo Yaya and Biso Gombo *kebeles* children significantly with an odds ratio of 1.41 and 10.29 respectively. **(See appendix - II)**

Result from experimental auction (BDM)

The BDM result shows that consumers were interested to pay more for yellow QPM and white QPM than the two CM grains without QPM nutritional information. Biso Gombo *kebele* interested to pay more for yellow QPM and white QPM over the CM grains with a premium of 44.5% and 4.13% respectively while Doyo Yaya *kebele was* willingness to pay for white QPM which is less by 0.04 cents over the conventional one but interested to pay more for yellow QPM with a premium of 11.1% over the yellow counterpart. The highest premium for both QPM grains has been seen on Waktola *kebele* before and without provision of QPM nutritional information.

Comparison has also been conducted between maize varieties and colors before offering any nutritional information. The result shows consumers were interested to pay 36.7% and 4.2% premium for yellow QPM and white QPM grain over the CM grain counterparts respectively.

Figure 1: WTP for grain within color and maize type before and without information



Source: Own computation; March: 201; N=210

Factors affects consumers WTP for QPM grain

Random effect model of generalized least square (GLS) was implemented to identify factors that affect consumers` WTP using main effect, cross effect, color effect and order effect.

The main effect result shows that Waktola *kebele* paid less for sample grains which is in line with the descriptive result. Livestock ownership was positively and significantly related to the WTP for the grains as it is related to income. The area is farming dominated area and peoples who have more livestock are recognized as better income group. That was the reason why WTP and livestock ownership positively related. It was also confirmed that Waktola *kebele* who have less average livestock ownership wants to pay less money than the other *kebeles*. Negative coefficient (-2.37) of CM indicates that consumers paid more premium for QPM grain than the conventional one. The result is consistent with the finding from descriptive result and is also in line with the study in Tanzania (Kiria, 2010; De Groote et al., 2014). However, high WTP for yellow grain than the white counterparts as positive coefficient of yellow grain (0.45). Study conducted in Kenya also shows that the study zones where yellow maize is most commonly preferred paid relatively high premium for the yellow plain maize meal than white plain maize meal (De Groote et al., 2010:4). Another interesting result that affirms the descriptive result was the relation between sensory quality and willingness to pay. The result shows positive and significant relation between sensory quality of maize *genfo* represented as mother's overall rating and willingness to pay for its grain with a positive coefficient(0.74) concurs with the study in Tanzania (Kiria, 2010).

The cross effect result also shows Waktola *kebele* bid less money for QPM relative to other *kebeles* represented by negative coefficient(-0.318) and net annual income were positively related to the WTP for the QPM grain. The result also explored the positive relation between mother's overall rating for QPM *genfo* and WTP for its grain. Lastly, the cross effect investigated yellow QPM paid more than the white QPM since positive coefficient of yellow QPM (0.73).

Another interesting result found was determinants of willingness to pay for the yellow QPM on color effect. Number of living children the mothers had was negatively and significantly related to WTP for yellow QPM. The reason seems it is directly related to income constraint of households having large family size. Order was also the core category considered as the factor to affect the willingness to pay for maize grains. It is directly related to the randomization of the sample of food and grain. The result shows negative coefficient of order in main effect and in cross effect too. The main effect result implies being the second order sample increases the likelihood to paid less and being the first order sample increases the probability to paid more relative to the second sample. **(See appendix - III)**

Effect of information on WTP

The descriptive result shows information has increased the bids for white and yellow QPM by 50.1% and 62.88% respectively and declined the bid for white CM by 20.1%. However, information has increased the bid for yellow conventional maize grain bid by 15%. Three possible reasons for the increment on yellow conventional maize bid. Firstly, no information was provided about the nutritional value of conventional maize grains and secondly, the appearance of yellow conventional maize grain is light yellow and in some extent similar to yellow QPM grain. Thirdly the grain size of yellow conventional maize is very large than other grain which are the possible reasons. The finding of Kassie et al., (2014) supports this idea which revealed that maize grain size is positively related to farmers WTP.

The impact of information among *kebele*, maize type and color also identified that Biso Gombo *kebele*

pay a premium of 56% for white QPM after provision of information while information has reduced WTP for white CM by a discount of 17% over the bid done before information. On other hand information has drove to increase WTP for yellow QPM by 70% on the *kebele*. Doyo Yaya *kebele* consumers were willing to pay a premium of 50% and 58% for white QPM and yellow QPM due to provision of nutritional information while they were willing to pay at a discount of 23% and 5% for white CM and yellow CM due to provision of information about QPM. Waktola *kebele* paid a premium of 60% for yellow QPM and 44% for white QPM.

Lastly, the study used independent sample t-test to affirm whether information has impact on willingness to pay for QPM grain using three status of information used on the experiment: no information, information, before and after information. The result shows, information has significant impact on the willingness to pay for the grains at 1% significance level with the overall premium ranges from 26% to 30% summarized below on **table 5.**

Table 5: Mean bids among information statuses during modified home use test

Information status	Mean	S.D	Sign.	Mean difference	Discount or premium%
No information (alone)	4.99	1.44	0.000***	1.34	26.85
With information (alone)	6.33	2.45			
Before information	4.99	1.43	0.000***	1.50	30.06
After information	6.49	2.42			
With information (alone)	6.33	2.45	0.335	0.16	2.527
After information	6.49	2.42			
N=210					
***=statistically significant at 0.1%, **=statistically significant at 0.5%; * = statistically significant at 1%					

Source: *Own computation*; March: 2015

Random effect model result **(Appendix - III)** also affirms positive impact of information on WTP. The result from the main effects shows that information has affected the willingness to pay positively and significantly at 1% significance level (coefficient = 0.722) which is consistent with the finding on descriptive result. The cross effect result also has positive sign which implies that information has increased the willingness to pay for QPM grain relative to non-informants (coefficient=1.522) and it has increased the WTP for yellow QPM (coefficient=1.711) seen on the color effect. The result is consistent with the findings of Meenakshi et al., (2010), Kiria, (2010) and Dee Groote, et al., (2010b).

Conclusions and policy recommendations

The study was tried to investigate the sensory acceptance of QPM traditional dishes and to elicit the magnitude of the willingness to pay for QPM grain among farmers using modified home use test and BDM auction mechanism.

The result from modified home use test examined that white QPM based *genfo* was significantly appreciated than the white conventional maize *genfo* in all attributes except in appearance and texture in hand and *genfo* from yellow QPM was 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*. Thus researchers, extensionists and organizations working in the area of food security and poverty reduction should use this sensory superiority of QPM to diffuse the technology. This encourages production and consumption of QPM among rural households and finally tackles malnutrition.

The experimental auction conducted using BDM mechanism also revealed that sample respondents were willing to pay more for QPM grain than for the conventional one. This encourages maize farmers, seed multipliers, seed supplying cooperatives and enterprises, food processors and industries, retailers and traders and then facilitates its adoption and indirectly fights malnutrition.

The result also shows significant difference between mean bids of consumers with information and without information. Information has boosted bids for white and yellow QPM grain and reduced the bids of white conventional maize grain. This finding has two important notions: first the finding implies that the nutritious value of maize is the concern of consumers and they were voluntary to spend more for the nutritious maize grain. Second, information has immediate effect in changing consumers mind to pay more for nutritious agricultural products. Therefore, concerning bodies should emphasize on formal and non-formal information dissemination mechanisms such as meetings, training, demonstrations, group discussion, advertisements and media to aware rural community, traders, industries and food processors about the nutritional value of QPM for its wider adoption.

The information is expected to raise new traders and food processors to fortify QPM with other products which in turn increases demand for QPM seed among producers. Thus, nutritious maize for Ethiopian

(NuME) projects with concerning bodies like national and regional research institution and seed enterprises should encourage multiplication and dissemination of the QPM seed aside biological and agronomic studies.

The econometric result shows the main driving factor for more willingness to pay for QPM was its sensory quality. Thus, the marketers and food processors could use the QPM favorable sensory characteristics to penetrate in to the market.

The result from experimental auction during random effect model shows that family size is negatively and significantly related to WTP. It is directly related to income constraint of households having large family size. Thus, government should consider those poor groups of households having large family size and constrained by income to use the technology.

To sum up, consumers` sensory acceptance is the main tool for the adoption and penetrating mechanism of new food related agricultural technologies. The researchers has identified three general issues from the study: consumers` sensory characteristics, consumers` true WTP and socio economic and demographic factors related to their sensory preference and WTP decisions. More over the study investigated the feasibility of the research methodologies used on the study to achieve the research objectives.

Future directions

Due to time constraint, the study was limited to only one maize potential zone of Ethiopia which is found in southwest part of the country. However, one zone is too few and cannot represent the rest of maize potential zones 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 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 target population for the reliability of the data since mothers were sometimes responding their own feelings simply by themselves during the evaluation when the child did not respond and faced difficulty while reading her child's facial satisfaction or dissatisfaction.

The order of sample presentation had significant impact on both sensory evaluation and willingness to pay observed during the experiments. Thus, care and attention should be given for the randomization of the samples of dishes as well as the grain for future similar experiments.

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APPENDIX

Appendix I: Ordinal regression model result for mothers overall rating

	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*; March: 2015

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

	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*; March: 2015

Appendix - III: Determinants of willingness to pay by random effect model.

Random-effects GLS regression	**Number of obs = 1260**
R-square: within = 0.6791	**Number of groups = 210**
between = 0.3159	**Observation per group = 6**
overall = 0.5592	**LR chi^2 = 2307.30**
corr(u_i, X) = 0 (assumed)	**Prob > chi^2 = 0.0000**

Variables		Coefficients	Std. Err.	P>|z|
Main effect	Kebele [Waktola]	-0.3279	0.0931	0.000***
	Mother age	-0.0018	0.0162	0.911
	Number of children	0.0047	0.0469	0.920
	Total livestock	0.0223	0.0127	0.079*
	Total net income	0.0000	0.0000	0.265
	Maize type [CM]	-2.3799	0.0827	0.000***
	Maize color [Yellow]	0.4548	0.1509	0.003***
	Mother overall score	0.7415	0.0712	0.000***
	Information	0.7225	0.0938	0.000***
Cross effect	Kebele [Waktola] * QPM	-0.3183	0.1322	0.016**
	Mother age * QPM	-0.0103	0.0186	0.578
	Total income * QPM	0.0000	0.0000	0.083*
	Color [yellow] * QPM	0.7275	0.2261	0.001***
	Mother overall * QPM	0.4020	0.2036	0.048**
	Information * QPM	1.5222	0.1326	0.000***
Color effect	Mother age *Yellow QPM	0.0534	0.0355	0.133
	Number of child *Yellow QPM	-0.165	0.0968	0.088*
	Total livestock *Yellow QPM	0.0361	0.0247	0.145
	Information *Yellow QPM	1.7119	0.1974	0.000***
Order effect	Order [second]	-0.1891	0.0666	0.005***
	Order [second] * QPM	-0.4608	0.2185	0.352
Constant		4.8873	0.6872	0.000***

Sigma_u 0.98294256
sigma_e 1.1473336
rho 0.42328793 (fraction of variance due to u_i)

Source: Research result; March: 2015