Effect of nutritional information and sensory quality on the willingness to pay for quality protein maize - results of a field experiment in Jimma zone, Ethiopia

Samuel Diro, Hugo De Groote and Nilupa Gunarata

Invited paper presented at the 5th International Conference of the African Association of Agricultural Economists, September 23-26, 2016, Addis Ababa, Ethiopia

Effect of nutritional information and sensory quality on the willingness to pay for quality protein maize - results of a field experiment in Jimma zone, Ethiopia

Contributed paper submitted to the 5th conference of African Association of Agricultural economists (AAAE), 22-25 September 2016, Addis Ababa, Ethiopia

April 11, 2016

Samuel Diro[1], Hugo De Groote[2] and Nilupa Gunarata[3]

[1] Ethiopian Institute of Agricultural Research (EIAR), Jimma, Ethiopia
[2] International Maize and Wheat Improvement Centre (CIMMYT), Nairobi, Kenya
Harvard School of Public Health, Boston, US

Abstract

Quality Protein Maize (QPM) has been fortified with lysine and tryptophan to improve the poor protein quality of conventional maize. For farmers to adopt QPM, there needs to be a market for it. This paper studies how nutritional information and sensory quality affects WTP for QPM grain, white and yellow, among rural consumers farmers in Jimma zone, Ethiopia. The study used affective tests, both central location test (CLT) and modified home-use (MHUT), and the Becker-DeGroot-Marschak (BDM) experimental auction mechanism to estimate WTP. The *CLT was conducted with 192 participants, while 210 mothers with children aged 6-23 months participated in the MHUT. To analyze the effect of information on WTP, the participants were randomly assigned to two treatment groups; first group was also provided with information after the BDM, and the BDM was repeated after information was provided. The results of the affective tests preparations of white and yellow QPM were significantly more appreciated than those of their white and yellow conventional maize counterparts. The BDM mechanism results revealed that respondents were willing to pay more for QPM grain than for conventional maize. Further, nutritional information boosted bids for white and yellow QPM grain and reduced the bids of white and yellow CM grains. The main factor affecting WTP for QPM was its sensory quality. The study, finally, recommends marketers and food processors to use the QPM's favorable sensory characteristics to penetrate in to the market and to emphasize on formal and non-formal information dissemination mechanisms for its wider adoption and dissemination.*

Key words: Sensory evaluation, willingness to pay, Becker-DeGroot-Marschak, central location test, modified home-use test

1. Introduction

Economists, psychologists and marketers are interested in determining the monetary value of non-market goods for a variety of reasons: 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). Elicitation of WTP is carried out for products in which a market does not yet exist and it is an indicator of the market value or quality of the commodity and a determinant of the incentives for product innovation.

Quality protein maize (QPM) is a biofortified maize variety with high lysine and tryptophan content and shown to have positive effects on malnutrition (Gunaratna et al., 2010). Different physiological and agronomic studies on QPM have been conducted in Ethiopia by international and national research organizations particularly where maize is dominantly produced and consumed. Quality protein maize has been disseminated in the *Jimma* administrative zone of Ethiopia in a limited number of districts and kebeles, with its own full agronomic recommendations like fertilizer rate, pest and disease management and spacing (Prasanna et al., 2001).

Even though all activities and decisions are colored by the consumer, only few QPM acceptance and preference studies have been conducted. Before diffusion of new agricultural technologies, it is necessary to examine its sensory acceptance and market potential using different experimental techniques.

The aim of this study is to identify the effect of quality protein maize nutritional information and sensory quality on the willingness to pay for its grain among consumers in Jimma zone: Omo Nada district and the specific objectives of the study are:

- ✓ To examine rural consumers' sensory preference of QPM and conventional maize dishes and if consumers can identify sensory difference between the dishes.
- ✓ To investigate determinants of rural consumers' willingness to pay for QPM grain.
- ✓ To identify whether sensory quality of QPM preparations and QPM nutritional information has an effect on consumers' willingness to pay for its grain.

The rest of this paper has four sections. Section two embraces key concepts like sensory evaluation, willingness to pay with a theoretical and empirical framework. Section three discusses data collection and data analysis methods used on the study. Section four focuses on the discussion of the results from experiments and section five summarizes the study and presents conclusions and policy recommendations.

2. Sensory evaluation and willingness to pay - review

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). Classification of sensory evaluation techniques is based on different factors used by scientists. Based on the goal of the study and criteria/characteristics demanded for the participating panelists, sensory evaluation techniques are divided into: discrimination analysis, descriptive analysis and affective analysis (Lawless and Heymann, 2010). Further, based the environment in which assessment is conducted, there are three methods of sensory evaluation: laboratory tests (e.g. triangular test), central location tests (CLT) or home-use tests (HUT) (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, such as schools, churches or community halls. The products are prepared out of sight and served on uniform plates, and each product is uniquely labeled. The participants are then asked to taste and evaluate the products, and determine in how far they like them. In a central location test, conditions are favorable for a high return of responses from a large sample size at low costs. However, the product is usually tested under conditions that are artificial in comparison to normal use at home 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. Color and other visual aspects that may not be fully under control though a prototype can be masked so that subjects can concentrate on the differences in flavor or texture under investigation. Triangular test with blind folded taste is ideal 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. Unlike central location taste where a product is prepared by one person and tasted by several people, in home use taste every household prepares the product according to their normal way and the respondents have repeated use of the product before the evaluation. 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, after which the second product is supplied and tasted (Meilgaard et al., 2007). A modification of this method has been developed in which respondents are asked to cook, taste and evaluate the product immediately after receiving the product at home, called the modified home use test (MHUT) (De Groote et al., 2014a).

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). The WTP function identifies the price an individual is willing to pay for a given level of quality, *q*, given specific levels of price *p* and utility *U* (Lusk and Hudson, 2004). Researchers use different auction mechanisms to elicit WTP based on the product of interest and the goal of the study. One of the most important tasks in the implementation of auctions is the decision of which mechanism to use. The most important factor is the incentive compatibility of the auction mechanism. An auction mechanism is considered theoretically incentive compatible if an individual's dominant strategy is to bid in such a manner that WTP is truthfully revealed.

The most commonly used auction mechanisms are: ascending bid, second price, Vickrey second price, random n^{th} price, first price, English, combinatorial private-collective auctions, and the Becker-DeGroot-Marschak (BDM) mechanism. Among them English auctions, Vickrey or second price auction, random n^{th} price auction and BDM are theoretically incentive compatible auctions (Lusk and Hudson, 2004).

In the BDM mechanism, participants submit their bid or offer price to purchase a product. This bid is compared to a randomly drawn price (for example, by drawing a ball with the price marked on it from an urn) from a distribution of prices, covering an interval from zero to a price greater than the anticipated maximum price, which any bidder could submit. If the participant's bid is higher than the random price, the participants buy a unit of the good and pay an amount equal to the random price; otherwise, the participant cannot buy the product. 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: 227-228). Second, although BDM auctions in groups are possible and have been reported, the BDM approach can be executed individually, which may be more convenient for researchers (Monchuk et al., 2007:96).

Different studies revealed that the magnitude of consumers' WTP for agricultural technologies and the type of payment vary with the nature of the technology. Studies on willingness to pay for new maize types such as genetically modified crops and QPM are few. Kimenju and De Groote (2008) studied Kenyan consumers' willingness to pay for genetically modified food and showed that consumer perceptions had an effect on WTP. Awareness and positive perceptions of the technology did not have significant effects. Negative perceptions, in particular perceived negative effects on health, had a clear negative effect on WTP. Trust in the government's ability to ensure food quality had a positive influence on WTP. Among socioeconomic factors, only income and education positively and significantly influenced WTP. Consumers' demographic characteristics such as age, gender, and presence of children had no significant effects on WTP according to the study.

Several studies have been conducted on consumer acceptance of QPM in East Africa, and generally show good acceptance (De Groote et al., 2014b). A study in Tanzania on QPM also showed that the age of the respondents positively and significantly affects WTP and sensory quality of stiff porridge had a positive effect on WTP for maize flour (De Groote et al., 2014) (De Groote et al., 2014a). The result also witnessed that difference in WTP among different geographical locations. Another study, in Southern Ethiopia, revealed that porridge from QPM was well accepted by mothers and children (Gunaratna et al., 2016, online). In comparison with these consumer studies on QPM, the present studies combines, in one area, the consumer acceptance of two major products (traditional bread and porridge) by three types of consumers (adults, mothers, and children), using two types of evaluation (affective tests and auctions). Moreover, the study adds information as an important component of the design.

3. Methodology

3.1.Consumer choice and utility theory

According to rational choice behavior, decision maker can rank possible alternatives in order of preference, and will choose from these options that one he or she considers most desirable, given taste and the relevant constraints placed on the decision making (Domencich & McFadden, 1975). The theory assumes, for two products there is completeness: either product A is preferred to product B, or product B is preferred to product A, or both product A and B are equally attractive. Consumers rank their preferences in order of possible situations from the least desirable to the most desirable. If a consumer prefers product A to product B, then it means that the level of utility derived from product A exceeds that from product B (Nicholson, 2005:78).

3.2.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, the proportional odds model can be used to analyze the preferences. Therefore, preference y^* depend up on observed factors x_i and non-observed factors ϵ_i which is modeled as:

$Y^* = x_i\beta+\epsilon_i$.. (1)

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

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

$$= \text{Ln}\left[\frac{\sum p(event)}{1-\sum p(event)}\right] = \beta_0+\beta_1 x_1+\beta_2 x_2+\ldots\ldots\beta_k x_k$$

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

$i = 1, 2, 3 \ldots k$

$j = 1, 2, 3\ldots p-1$

Where, α_j or β_0 = thresh hold; β_1 = parameters; $x_{i,\ 1}$ = sets of factor or predictors.

3.3.Description of the study area

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 district, one of 18 districts of the zone, is found at 72 km away from Jimma town. The district has 39 *kebele*[1] and two urban centers. There are 47, 646 households in the district and 5.8 is the average family size. Subtropical, 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).

3.4.Data types and sources

The source of data for this specific study was experimental data. The data was collected since March 2015 by well-trained enumerators. In addition to experimental data; demographic and socioeconomic data such as age, education level, family and farm size, annual income and expenditure and livestock ownership of the respondents were collected.

---

[1] The smallest administrative unit in Ethiopia

3.5. Sampling procedure

A three stage sampling procedure was followed to select sample households. In the first stage, a maize potential *district* was been identified in collaboration to CIMMYT staff: *Omo Nada district*, which was purposely selected. In the second stage, four potential *Kebeles* were purposively selected in collaboration with concerned experts of the district office of agriculture. Finally, rural households were selected randomly based on sampling frame identified with the help of the development agents of the respective peasant association.

3.6.Data collection techniques

Triangular test, central location test and modified home use test were the affective tests used to investigate the sensory characteristics of QPM and compare them against the control product by using traditional maize preparations, in particular *dabo*, traditional leavened bread, and *genfo*, a stiff porridge. The BDM mechanism was used to elicit consumers' willingness to pay of grains.

A triangle test is a method used to determine whether a sensory difference exists between two products. The products tested were white conventional maize versus white QPM, and yellow conventional maize versus yellow QPM. Each pair was compared in the triangle test by 16 consumers randomly selected from four *kebeles*. Each respondent was told the three *dabo* samples presented contained two samples of the same product and one sample from a different product, all three labeled differently. Participants were asked to identify the odd sample from these three samples served by tasting, smelling, checking the hand/mouth texture or any method that they wished to use to identify the odd sample blind folded.

Central location test were organized with 48 participants in each of the four *Kebeles*, 192 in total, either at the *Kebele* administration or at the farmers' training center hall (Figure 1). Farmers were requested to evaluate four types of *dabo:* either made of 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". The test was double blind: neither the consumers nor the enumerators knew 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, all using a five-point hedonic scale.

Data for the modified home use test were collected from 210 randomly selected women with 6-23 month aged children. The study was between *genfo* prepared from white QPM and white conventional maize and yellow QPM and yellow conventional maize types. Half a kilogram of maize flour from one of the two varieties was provided to the women and they prepared local food *genfo* (porridge) and feed their young children at home. Then, they gave their own evaluation, as well as their impression of the child's evaluation, based on the body language and facial expressions of the child when eating the product. All evaluations were on a 5-point hedonic scale. The attributes tested in the modified home use test were appearance, hand feel, mouth feel, taste, aroma and overall. Neither the consumers nor the enumerators knew from which maize type the flour came from.

Data collection for experimental auction was combined with central location test and modified home use test; so that each consumer participated on both experiments were asked to elicit their willingness to pay using BDM auction mechanism (Figure 2).

For the experimental auction, during the central location test, half of respondents were provided with nutritional information on QPM, while the other half were not. For the experimental auctions with MHUT, participants were organized in three equal groups. The first group did the auctions without the nutritional information on QPM, while the second group did the auctions with the information. Participants assigned to the third group first did the auction without the information, followed by the auction with information.

To help the participants understand the BDM procedure, a test round with biscuits was first organized with enough show up fee. After the test round, respondents were provided with sufficient money for the actual auction. They were presented with a kilogram (or four *tasa*[2] in the local units) of each of the four types of maize grain for central location test and two types of maize grain for modified home use test. The grain was provided in clear plastic bags, containing a label with same codes used during the affective tests. The grain for the auctions was presented in in random order for the CLT and in alternate order for the MHUT 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 products. 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 that round was compared to a number randomly drawn from a normal distribution with mean ETB 4[3]. If the respondent's bid was higher than the random number, the purchase took place at the random number and money was exchanged for product.

3.7.Data analysis techniques

For the triangular test, the assumption that there is no noticeable difference between the two products tested is rejected if the number of correct responses (or number of times the odd product is

[2] Local measurement of grain approximately equals to 250 gm.
[3] Local market price of four *tasa* of maize grain on march 2015

detected) is significantly larger than the number that would have been expected if respondents guessed randomly (with a probability of guessing correctly of 1/3). This number can be obtained from the appropriate χ^2 distribution or from the tabled values particularly prepared for triangular test (http://www.fao.org/docrep/v7180e/V7180E12.HTM).

The scores provided by the participants for each of the sensory attributes during central location test and modified home-use test and individual bid during the auction was analyzed using descriptive statistics.

Farmers' willingness to pay differs among products, but can also differ with income, location and knowledge of QPM's nutritional quality. To take into account the correlation between the scores of one respondent for different products, a random effect u_i was added to the following model on WTP by consumer *i* for product *j*, using STATA 12.1. The following model

$$y_{ij} = \alpha + \alpha' x_j + \beta' f_i + \gamma' d_i + \rho' z_j + x'_j A f_i + x'_j B d_i + x'_j C z_j + \mu_i + \nu_{ij} \qquad \text{......................} (3)$$

In this model, the vector ***fi*** of represents consumer characteristics like gender, age, sex, years of formal education, the vector $\boldsymbol{d_i}$ includes location effects, vector z_i to include QPM nutrition information effect, matrix A represents the cross effects of consumer characteristics on WTP for the different products, matrix B represents the cross effects of location, and matrix C represents the cross effects of nutritional information (De Groote et al., 2010a).

4. Result and discussion

4.1. Characteristics of survey respondents

The mean age of respondents of CLT was 39 years and the average land ownership of the farmers was 1.24. The average land covered by maize was 0.51 hectares during CLT.

The data during modified home-use test also shows that the average age of mothers was 30 years and the average age of children participated on the experiment was 19.38 months. The average land size of the respondents was 0.83 hectare and average land covered by maize was 0.39 hectares. The demographic and socio economic features of respondents participated on both central location and modified home-use test is summarized below on **Table 1.**

4.2 Result of triangular test

During the CLT, four products were tested: *dabo* (leavened bread) made from white or yellow QPM, and from white or yellow conventional maize. For the triangle test, we are interested if consumers can tell, by sensory evaluation, the difference in maize type (QPM vs. CM) and in maize from different colors (white vs. yellow). Therefore, four comparisons were made. First QPM was compared to CM and that for both colors (white and yellow). Next, white maize was compared to yellow and that for both types (QPM and CM) (Table 2).

For the triangle test, 16 respondents were asked to distinguish between each of the four pairs. For the first pair, *dabo* from white QPM and white CM, out of 16 respondents, 11 respondents could correctly identify the odd sample. This number equals the critical number for a sample size of 16 (11, for a significance level of 0.5%), so the assumption of "no difference" is rejected (p = 0.004). It is concluded that there is a significant sensory difference between *dabo* prepared of white QPM and white conventional maize.

Similarly, for the samples of *dabo* of yellow QPM and yellow conventional maize, all but one respondent (15) correctly identified the odd sample, and for the samples of white QPM and yellow QPM, 12 correctly identified the odd samples, again the assumption of "no difference" is rejected for those pairs.

However, for the last comparison between white and yellow conventional maize, only half of the respondents identified the odd sample. Since this number (8) is less than the critical number (11), we cannot reject the null hypothesis and thus, there is no statistical evidence to conclude the two maize *dabos* are different.

4.3. Affective tests

During the CLT, participants evaluated the *dabo* made from the four maize varieties. Yellow QPM was clearly the preferred variety for *dabo*, followed by white QPM (Figure 3). The CM varieties were less appreciated the yellow one slightly better. Accordingly, 58% of respondents gave the score “like very much” for yellow QPM *dabo* and 28% of respondents gave “like very much” score for white QPM *dabo*. On other hands, only 8% of respondents gave the score “like very much for white CM *dabo*. However, neither of respondents gave “dislike very much” score for any preparation of *dabo*.

During the MHUT, mother and children evaluated *genfo* made from two varieties, either both white or both yellow. The mothers prepared the *genfo* on the spot, tasted it and let their child taste it. The mothers clearly liked the *genfo* from QPM varieties best, and the yellow one a bit more than the white QPM. Most mothers (82%) gave the score “like very much” for yellow QPM *genfo* and 46% of them gave “like very much” score for white QPM *genfo*. On other hands, only 3% of respondents gave “like very much” score for yellow CM *genfo*. However, no consumers gave “dislike very much” score for any preparation of *genfo.*

The result of children overall evaluation of *genfo* during modified home-use test also showed that neither of children gave “dislike very much” score for any type of *genfo* and 23% of children disliked the overall attributes of yellow conventional maize *genfo*. On other hands, 59% of children gave the score “like very much” and 45% of them gave the score “like very much” for white QPM as summarized below.

4.4. Factors affecting consumer’s preferences for maize preparations

Ordinal logistic regression model was used to analyze factors affecting consumers’ preference of maize dishes both during central location and modified home-use test. *Dabo* prepared from QPM was positively and significantly appreciated than the conventional maize *dabo* during CLT (coefficient=1.927). When we take the exponent, it resulted 6.9 which means that QPM *dabo* was 6.9 times appreciated than the conventional counterpart. The results of the CLT showed the yellow *dabo* was significantly more appreciated than the white *dabo (coefficient*=0.675).

The main effect result of ordinal logistic regression model showed that consumers of Waktola kebele significantly appreciated the maize *dabos* evaluated (coefficient=0.785) and the cross effect result also witnessed that Waktola kebele appreciated the QPM *dabo* significantly (coefficient=0.898). Farmer's land holding had negative and significant effect on the preference of maize *dabos* both during main and cross effects. The reason behind could be large land is related to wealth of an individual on the study area and wealthy individuals used to consume *teff* (common stable cross in Ethiopia) rather than maize. The main effect and the cross effect result of ordinal regression also showed sample presentation order has positive and significant on the preference during CLT (coefficients; 0.276 and0.120).

The results of the MHUT also showed that QPM *genfo* was significantly better appreciated than the CM *genfo* (coefficient=2.725) which is consistent with the finding on the CLT. Regarding color, the yellow *genfo* was significantly more appreciated than the white *genfo* during MHUT (coefficients = 0.352). The result of the main effects in the ordinal regression showed that participants in Waktola scored the different *genfos* substantially less than their counterparts from the other Kebeles. The cross effects also showed that participants from Waktola kebele liked QPM *genfo* less. The results also show that the order of sample presentation is positive and significant (main effect). The cross effect result revealed that order of sample presentation has positive and significant impact on the preference of QPM *genfo* which implies QPM *genfo* collected significantly high score when it was presented first.

4.5. Willingness to pay with BDM

The result of experimental auction during central location test showed that consumers were willing to pay more for QPM maize grain than for the conventional one without provision of nutritional information. Accordingly, consumers were willing to pay a premium of 15% for white QPM grain over the white CM and willing to pay a premium of 21.77 % for the yellow QPM over the yellow CM grain.

The result during modified home-use test also revealed that consumers were interested to pay more for yellow QPM and white QPM than the two CM grains before offering any nutritional information. During modified home-use test, consumers were willing to pay a premium of 26.82% for yellow QPM over yellow conventional maize and willing to pay a premium of 4.03% for white QPM over the white conventional maize grain.

4.6. Effect of information on Willingness to pay

The study also explored the effect of nutritional information on the willingness to pay both during central location and modified home-use test. The result from central location test shows that information has increased the bid of white QPM grain by 29% and yellow QPM by 23% (Figure 4). However, information has reduced the willingness to pay for white conventional maize grain by 2.1% and for yellow conventional maize grain by 5.3%. Impact of QPM nutritional information on WTP during modified home-use test also showed that information has increased the bids for white by 33.63% and yellow QPM by 36.02% (Figure 5). However, information declined the bid for white CM grain by 19.4% and increased the bid for yellow conventional grain bid by 15%.

4.7. Determinants of consumers' willingness to pay

Generalized least square (GLS) random effect model was used to investigate factors determine consumers' WTP of the grains during both CLT and MHUT. The analysis result included the main effect, cross effect and information effect.

During CLT, consumers were willing to pay a significantly higher premium for QPM grain than the conventional counterpart (coefficient=1.4) which corroborates with the findings of descriptive results. Consumers were also willing to pay a premium for yellow maize grain over white grain as observed by the main effect (coefficient=0.2) and a premium for yellow QPM, as seen from the cross effect (coefficient=0.45).

The main effect of random effect model shows that Waktola kebele paid significantly higher price for grains (coefficient=0.56). The overall evaluation had, after the QPM variety and the Kebele of Waktola, the highest coefficient (0.49), indicating the strong effect of the sensory characteristics on WTP. The order of presentation had a negative effect on WTP both during main and cross effects and the reason might be diminishing marginal utility. Order of sample presentation did not have a significant effect on WTP during the CLT. The study was also tried to reveal the effect of information on the willingness to pay of grains. The results show that information positively affected the willingness to pay for grain generally and also boosted the willingness to pay for QPM grain and, to a lesser extent, for yellow grain.

During the MHUT, consumers were also willing to pay a significant premium for QPM grain over the conventional grain MHUT (coefficient=2.4) which corroborates with the findings on CLT. The study was also tried to explore the relation between WTP and the overall attribute of the *genfo* during affective test. The mother's overall score had a positive and significant effect on the

WTP of the grains (coefficients = 0.744), while its cross effect with QPM was also high and significant (0.440).

Further, mothers were willing to pay significantly higher price for yellow maize grain than the white grain (coefficient = 0.441). Similarly, they were willing to pay significantly higher price for yellow QPM grain (coefficient on cross effect = 0.710). The findings are consistent with the findings on CLT. In the MHUT, however, total number of cattle had a positive and significant impact on the willingness to pay in general (main effect) and for QPM (cross effect). This is understandable, since the number of cattle measures the wealth of the household on the study area.

Unlike the CLT, order of presentation had a significant, and negative effect on WTP during the MHUT, and also a negative cross-effect on QPM. In this test, only two products were presented, but they had to be cooked in the home first. Unlike the CLT, participants from the Waktola Kebele were willing to pay significantly less for grain than those in other Kebeles (coefficient=-0.318) and significantly less for QPM grain (cross effect = -0.322). The effect of information on WTP for grain for the mothers in the MHUT, similar to participants in the CLT, was an increase in WTP in general and specifically for QPM and yellow color, although in this case the cross effect for yellow was larger than for QPM.

5. Conclusions and policy recommendations

The aim of the study was to explore the sensory difference between QPM and conventional maize in traditional dishes and to elicit the willingness to pay for QPM grain along with the impact of sensory quality of QPM and nutritional information on willingness to pay among consumers in southwest Ethiopia using triangular test, affective tests and BDM procedure.

The results of triangular test show that consumers can differentiate between *dabo* made of white QPM and white conventional maize, and yellow QPM and yellow conventional maize. The result of central location test also identified the scores of *dabo* prepared from white QPM were consistently higher than that of white conventional maize. Similarly, *dabo* from yellow QPM was significantly more appreciated than *dabo* from yellow conventional maize.

The results from modified home-use test showed that the porridge from yellow QPM was much more appreciated than porridge from yellow conventional maize in all attributes. White QPM, on the other hand was significantly more appreciated than its white conventional maize counterpart in all attributes except for appearance and texture in hand. Similarly, childrens’ evaluation of porridge that their overall scores for QPM of both colors was significantly higher than their conventional maize counterparts.

The experimental auctions also revealed that respondents were willing to pay more for QPM maize grain than for the conventional maize during both the central location and modified home-use tests. The result also shows significant increase in WTP of consumers who received information. Information boosted WTP for white and yellow QPM grain and reduced the WTP for white and yellow conventional maize grains. This implies that the nutritious value of maize is a concern of consumers who are volunteering to spend more for the nutritious maize grain.

The order of sample presentation had a significant impact on WTP during the MHUT. Unlike other studies, the effect of the first sample was negative, although the effect was only observed during MHUT. Great care should therefore be given to the proper randomization of the different products offered in the auctions.

We conclude that researchers, extention officers and organizations working in food security and poverty reduction could take advantage of the sensory acceptance of QPM to disseminate and diffuse the technology. This will encourage production and consumption of QPM among rural households and help reduce malnutrition. Further, the increased WTP for QPM should encourage maize farmers to adopt, but also seed multipliers, seed supplying cooperatives and enterprises, food processors and industries, retailers and traders to facilitate its adoption and thereby indirectly fights malnutrition. However, a quality control system is tantamount to make the premium move through the market value chains. Finally, the increase of WTP with information indicates concerning bodies should emphasize 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 and dissemination.

Acknowledgments

The authors would like to gratefully acknowledge the financial support received from the DFATD through the NuME project, managed by the International Maize and Wheat Improvement center (CIMMYT). Special thanks also go to NuME's coordinator, Adefris Teklewold (PhD) and staff members Demisie Belayneh and Antenaene Abeiy. Our sincere gratitude also goes to Dawit Alemu

(PhD), Director of Agricultural Economics, Extension and Gender Research Division of EIAR, Taye Kufa (PhD), Jimma agricultural research center director and all enumerators and respondents.

References

Anonymous (1975). Minutes of division business meeting. Institute of Food Technologists – Sensory Evaluation Division, IFT, Chicago, IL.

Becker G., De Groote H, and Marschak J. Measuring utility by a single response sequential methods. Behavioral science: 9(1964) 226-232.

De Groote, H., Chege, C.K., Tomlins, K., Gunaratna, N.S., 2014a. Combining experimental auctions with a modified home-use test to assess rural consumers' acceptance of quality protein maize, a biofortified crop. Food Quality and Preference 38, 1-13.

De Groote, H., Gunaratna, N.S., Okuro, J.O., Wondimu, A., Chege, C.K., Tomlins, K., 2014b. Consumer acceptance of quality protein maize (QPM) in East Africa. Journal of the Science of Food and Agriculture 94, 3201-3212.

De Groote, H., Kimenju, S.C. & Morawetz, U.B. (2010a). Estimating consumer willingness to pay for food quality with experimental auctions: the case of yellow versus fortified maize meal in Kenya (forthcoming). Agricultural Economics.

De Groote, H., Tomlins, K., Haleegoah, J., Awool, M., Frimpong, B. N., Banerji, A., Chowdury, S. & Meenakshi, J.V. (2010b). Assessing rural consumers‟ WTP for orange, biofortified maize in Ghana with experimental auctions and a simulated radio message. *Paper presented at African Agricultural Economics Association, at Cape Town, South Africa, 19th - 23rd September 2010.*

De Groote, H., Chege, C.K., Tomlins, K., Gunaratna, N.S., 2014. Combining experimental auctions with a modified home-use test to assess rural consumers' acceptance of quality protein maize, a biofortified crop. *Food Quality and Preference* **38**, 1-13.

Domencich, T.A. & McFadden, D. (1975). Urban travel demand a behavioral analysis: Contributions to economic analysis. Amsterdam: North Holland.1-213.

Gunaratna N.S., De Groote H., Nestel P., Pixley K.V., McCabe G.P. (2010) A meta-analysis of community-based studies on quality protein maize. Food Policy 35:202-210.

Gunaratna, N.S., Bosha, T., Belayneh, D., Fekadu, T., De Groote, H., 2016 (online). Women's and children's acceptance of biofortified quality protein maize for complementary feeding in rural Ethiopia. *Journal of the Science of Food and Agriculture*.

Kassie, G. T., A. Abdulai, J. MacRobert, T. Abate, B. Shiferaw, A. Tarekegne, and D. Maleni, (2014) .Willingness to pay for Drought Tolerance (DT) in Maize in Communal Areas of Zimbabwe. Paper presented on 88th Annual Conference of the Agricultural Economics Society, Agro Paris Tech, and Paris, France.

Kimenju, S.C. and De Groote H. (2008). Consumer willingness to pay for genetically modified food in Kenya. *Agricultural Economics* 38 (2008) 35–46.

Kiria C. (2010). Acceptance, perceptions and willingness to pay for quality Protein Maize(QPM) by rural consumers in Tanzania. Working paper. University of Pretoria.

Lawless, H.T. and Heymann, H. (2010). Sensory Evaluation of Food: Principles and Practices, New York, USA: Springer.

Lusk, J. and Shogren, J., (2007). Experimental Auctions Methods and Applications in Economic and Marketing Research. Published in the United States of America by Cambridge University Press, New York.

Lusk, J. L., and Hudson, D., (2004). Willingness-to-pay estimates and their relevance to agribusiness decision making. Rev. Agric. Econ. 26(2), 2–19.

Meenakshi, J.V., Banerji, A., Manyong, V., Tomlins, K., Hamukwala, P., Zulu, R. & Mungoma, C. (2010). Consumer acceptance of provitamin A orange maize in rural Zambia: HarvestPlus working paper No.4. HarvestPlus Washington, DC,USA 1-39.

Meilgaard M. C., Civille G. V. and Carr B. T. (2007) . Sensory Evaluation Techniques, Fourth Edition, CRC Press, Taylor and Francis Group, USA.

Meullenet, F., Xiong, R. & Findlay, C.J. (2007). Ordinal logistic regression models in consumer research, in multivariate and probabilistic analyses of sensory science problems. Oxford ,UK: Blackwell publishing.129-161.

Monchuk, D.C., Rousu, M.C., Shogren, J.F., Nonnemaker, J. & Kosa, K.M. (2007). Decomposing the value of cigarettes using experimental auctions. Nicotine and Tobacco Research,9: 93–99.

Nicholson, W. (2005). Microeconomics theory: basic principles and extensions. 9th ed. Ohio: Thomson, South-western.1-671.

Oparinde A., Birol E., Murekezi A., Katsvairo L., Diressie M.T., Nkundimana J.,and Butare L., (2015). Consumer Acceptance of Bio fortified Iron Beans in Rural Rwanda: Experimental Evidence. HarvestPlus Working Paper; March 2015

Prasanna, B.M., S.K. Vasal, B., Kassahun, and N.N., Singh. (2001). Quality protein maize. Current Science 81:1308-1319.

Wertenbroch K. , Skiera B. Measuring Consumers' Willingness to Pay at the Point of Purchase // *Journal of Marketing Research*, 2002. 39(2). pp. 228-241.

Tables

Table 1

Characteristics of respondents during central location and modified home-use test

Variables	Central location test (N=192)		Modified home-use test (N=210)	
	Mean	S.D	Mean	S.D
Age	38.95	10.42	30.13	5.77
Education level (years of formal education)	2.48	2.94	1.59	2.78
Family size (members)	6.71	2.76	3.94	2.06
Land (ha)	1.24	0.85	0.83	0.79
Maize land (ha)	0.51	0.41	0.39	0.34
Net annual income ($US)	235.16	150.94	237.42	137.90
Number of cattle	3.99	2.88	2.63	2.37
Age of children	-	-	19.38	5.55

Table 2
Triangular test result (N-16 for each comparison)

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

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

Table 3
Ordinal logistic regression result during central location and modified home-use test

Variables		Ordinal logistic regression result during central location test (N=192)			Ordinal logistic regression result during modified home-use test (N=210)		
		Estimate	S.E	P-value	Estimate	S.E	P-value
Main effect	Sample type [1=QPM]	1.927	0.134	0.000***	2.725	0.255	0.000***
	Sample color [1=Yellow]	0.675	0.118	0.000***	0.352	0.207	0.090*
	Kebele [1=Waktola]	0.785	0.182	0.000***	-0.452	0.256	0.077*
	Kebele [2=Burka Asendabo]	0.014	0.181	0.939	0.446	0.268	0.095*
	Sex [1=male]	-0.091	0.130	0.483	-	-	-
	Respondent's age	0.005	0.006	0.388	0.004	0.023	0.877
	Years of formal education	0.020	0.022	0.371	0.014	0.040	0.721
	Land holding	-0.156	0.074	0.037**	0.099	0.137	0.469
	Sample order [1=first]	0.276	0.164	0.092*	0.728	0.210	0.001***
Cross effect	QPM * [Sample color 1=Yellow]	1.118	0.170	0.000***	1.787	0.341	0.000***
	QPM * [kebele 1= Waktola]	0.898	0.265	0.001***	-0.823	0.385	0.032**
	QPM * [kebele 2= Burka Asendabo]	-0.022	0.260	0.932	0.709	0.429	0.098*
	QPM * [Sex 1=male]	-0.177	0.188	0.345	-	-	-
	QPM * Respondent's age	0.007	0.009	0.421	0.052	0.036	0.143
	QPM * Years of formal education	0.021	0.033	0.521	0.041	0.063	0.518
	QPM * land holding	-0.187	0.107	0.081*	0.111	0.204	0.586
	QPM * [Sample order 1=first]	0.120	0.078	0.125	0.600	0.324	0.064*
Threshold	[Overall = 1.00]	-5.910	0.752	0.000	-4.336	0.845	0.000
	[Overall= 2.00]	-2.587	0.301	0.000	-1.221	0.639	0.056
	[Overall = 3.00]	-0.735	0.275	0.008	2.285	0.653	0.000
		Pseudo R-Square (Nagelkerke) = 36.94 Pearson chi^2=9041.49***			Pseudo R-Square (Nagelkerke) = 43.58 Pearson chi^2=1509.68***		

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

Table 4

Consumers` willingness to pay for grains before and without provision of nutritional information during central location and home-use test (in ETB)

Grain variety	During central location (N=192)			During modified home-use test (N=140)		
	Mean	S.D	Discount or premium in %	Mean	S.D	Discount Or premium in %
White QPM	5.48	1.56	11.49	5.21	1.94	4.03
White CM	4.85	1.47		5.00	1.91	
Yellow QPM	6.22	1.96	21.77	5.63	1.71	26.82
Yellow CM	4.88	1.65		4.12	1.60	

Table 5

Random effect model result during central location and modified home-use test

Variables		GLS_random effect model during central location test (N=192)			GLS_random effect model during modified home-use test (N=210)		
		Coefficient	S.E	P>|Z|	Coefficient	S.E	P>|Z|
Main effect	QPM variety	1.398	0.105	0.000***	2.378	0.082	0.000***
	Yellow grain	0.209	0.095	0.027**	0.441	0.148	0.003***
	Kebele Waktola]	0.555	0.0565	0.000***	-0.318	0.092	0.001***
	Male	0.118	0.190	0.534	-	-	-
	Age	-0.005	0.007	0.485	-0.003	0.016	0.829
	Years of formal education	-0.027	0.023	0.237	0.019	0.028	0.496
	Number of living children	-0.008	0.0267	0.755	0.008	0.047	0.862
	Number of cattle	0.036	0.025	0.137	0.108	0.325	0.001***
	Overall evaluation	0.486	0.072	0.000***	0.744	0.071	0.000***
	Order [1=First]	-0.043	0.042	0.307	-0.188	0.066	0.005***
Cross effect	QPM * Grain color [1=yellow]	0.454	0.142	0.001***	0.710	0.224	0.002***
	QPM * kebele [1= Waktola]	1.004	0.081	0.000***	-0.322	0.131	0.014**
	QPM * Sex [1=male]	0.007	0.239	0.978	-	-	-
	QPM * Respondent's age	-0.009	0.009	0.353	-0.0003	0.023	0.988
	QPM * Years of formal education	-0.035	0.033	0.291	-0.0104	0.041	0.800
	QPM * Number of living children	-0.038	0.037	0.288	-0.078	0.066	0.240
	QPM * Number of cattle	0.027	0.034	0.421	0.118	0.046	0.010**
	QPM * Overall evaluation	0.557	0.118	0.001***	0.440	0.203	0.030**
	QPM * Order [1=First]	-0.066	0.068	0.334	-0.510	0.216	0.018**
Information effect	Information	0.765	0.114	0.000***	0.716	0.092	0.000***
	Information * QPM	1.976	0.166	0.001***	1.507	0.131	0.000***
	Information * Yellow grain	0.305	0.117	0.009***	1.712	0.197	0.032**
	Information*kebele [1=Waktola]	0.526	0.058	0.000***	-0.262	0.141	0.062*
Constant		2.949	0.687	0.000***	4.934	0.678	0.000***
		R-sq.: Overall = 0.3145 Sigma_u | 0.7513 sigma_e | 1.5961 rho | 0.1814 (fraction of variance due to u_i) Number of observation = 1152			R-sq.: Overall = 0.5659 Sigma_u | 0.9662 sigma_e | 1.1473 rho | 0.4149 (fraction of variance due to u_i) Number of observation = 1260		

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

Figures

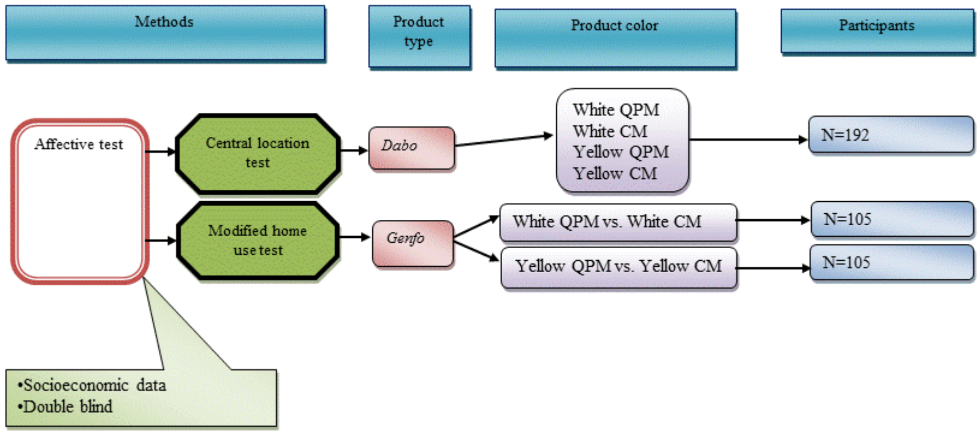

Figure 1. Study design for the affective tests

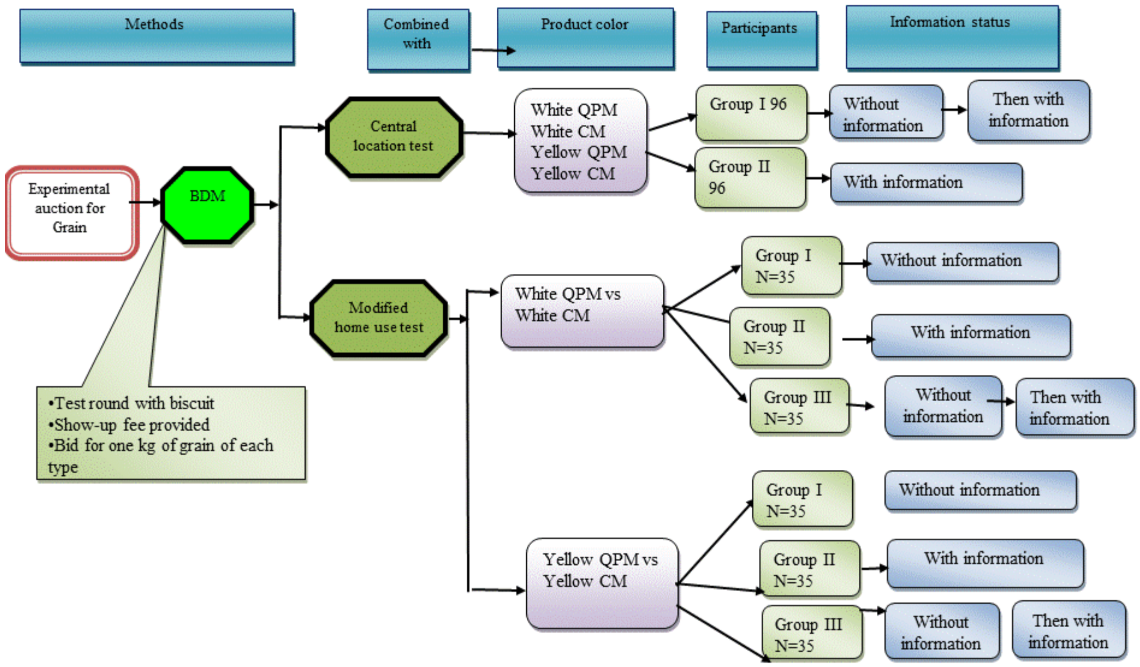

Figure 2. Study design for the experimental auctions.

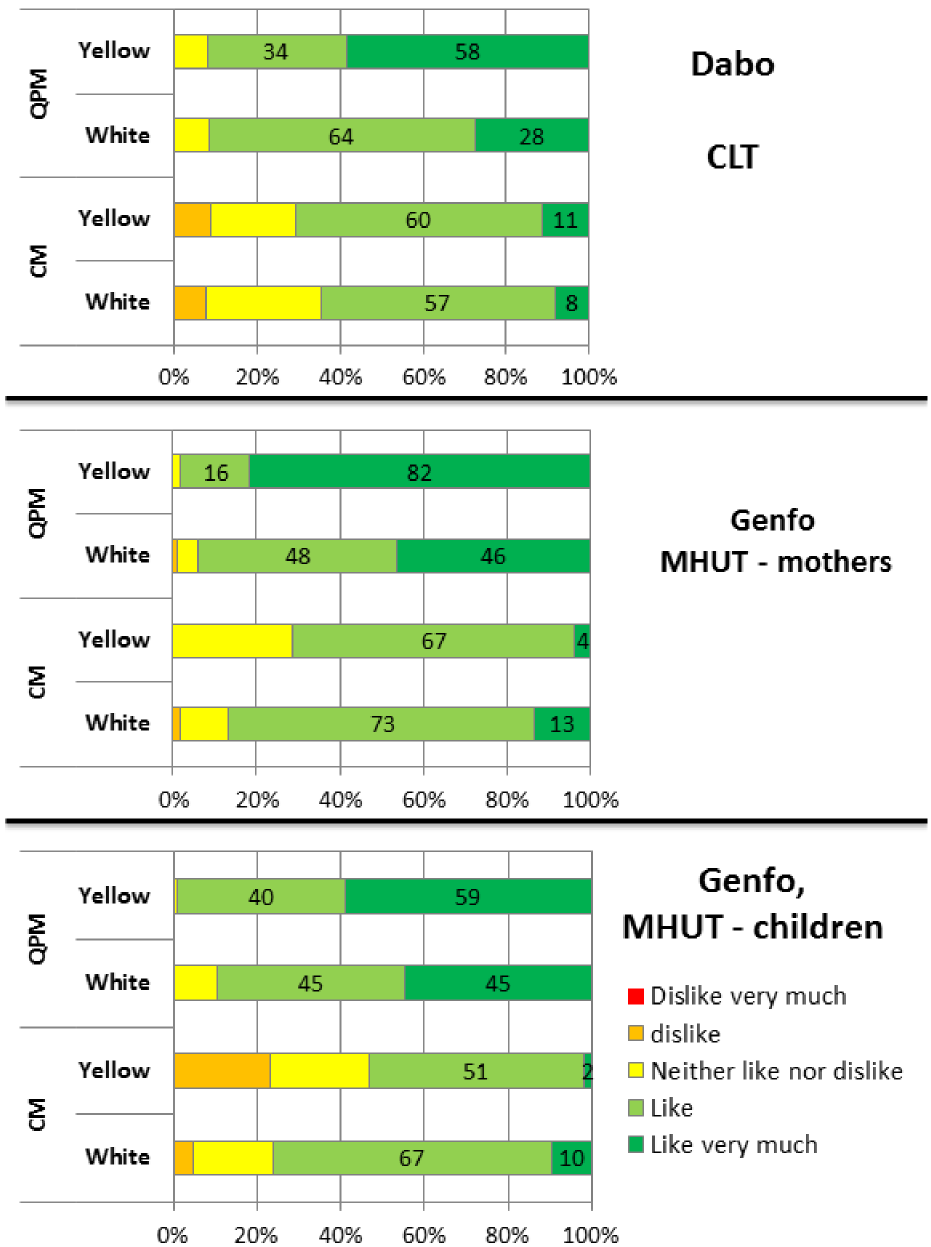

Figure 3. The results of the affective tests, in the CLT (with *dabo*) and MHUT (with *genfo*, and by mothers and children)

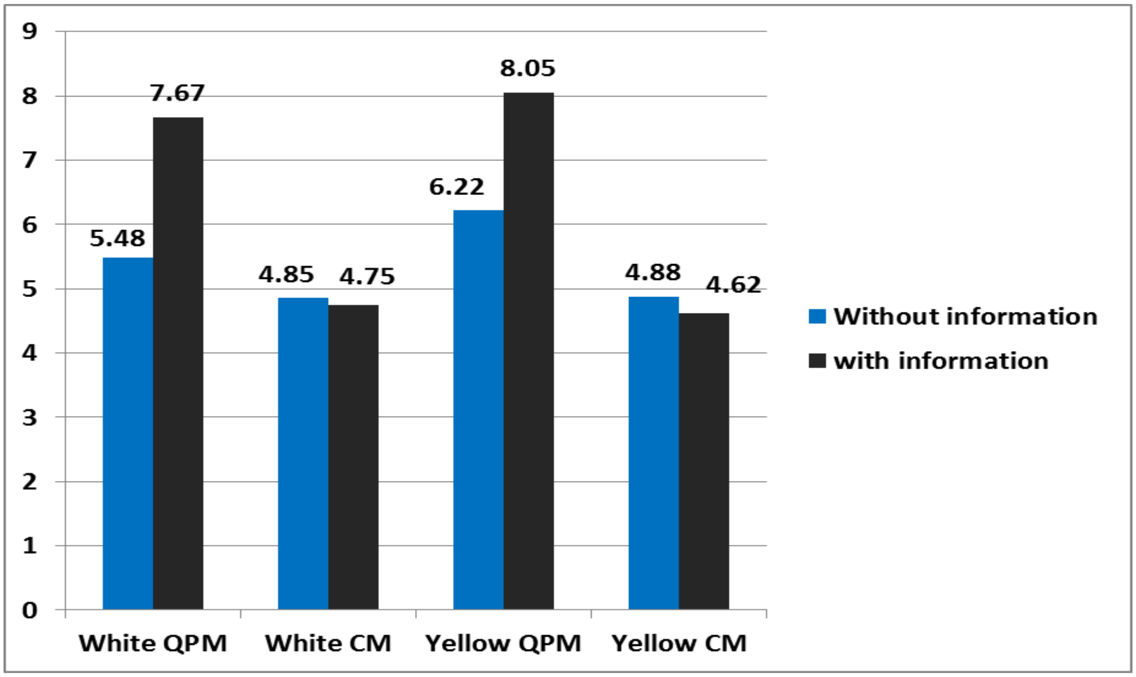

Figure 4: Effect of nutritional information on willingness to pay during central location test

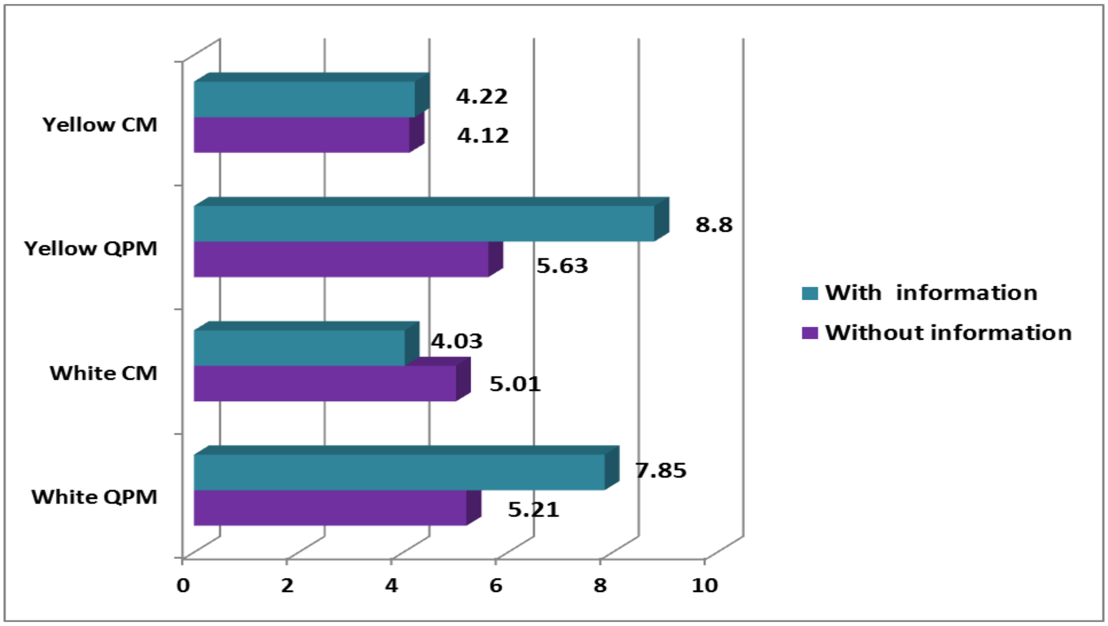

Figure 5: Effect of nutritional information on WTP during modified home-use test