Willingness-to-pay for sugar fortification in Western Kenya.

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Abstract

Food fortification presents practical and cost-effective alternative to the fight against micronutrient malnutrition. Vitamin A deficiency and lack of iron bears the greatest economic importance in Kenya. To understand the potential for mass industrial fortification programs, the study assessed the consumers' willingness-to-pay for fortified sugar using choice experiment approach, on a sample of 162 sugar consumers drawn from Western Kenya. The results revealed that consumers are willing to pay positive premiums for most fortified sugar attributes, except the attribute involving sensory characteristics. The study conclude by suggesting specific sugar fortification targets for various consumer segments.

Keywords*: Vitamin A deficiency, fortification, sugar, choice experiment.*

1. Introduction

Micronutrient deficiency or 'hidden hunger' as commonly known by most researchers, commands great attention in nutrition policy today. The phenomenon refers to a situation where individuals gain access to food in adequate quantities but lacks balance in terms of nutrients (Okello et al., 2013). The authors further clarify that this satiation implies that individuals may have food but are unable to utilize the food in order to have a functional life.

Vitamin-A (VA) and Iron deficiencies, pose the greatest economic threat, among the micronutrient viz, in Kenya (WHO, 2006). VA is mainly obtained from animal sources in the form of retinol that are usually expensive hence out of reach of most households. Other sources include a few leafy vegetables and fruits in the form of pro-vitamin-A carotenoids. These are less easily absorbed and utilized by the human body (less Bio-available) than the VA coming from animal products (Kimenju et al., 2005). Since VA from plant sources is usually found in large amounts in only a few fruits and vegetables, many of which are highly seasonal, low income populations may suffer from VAD unless VA is available in processed foods such as sugar, oils, and staples that are widely consumed by such households. Fortification of foods with minerals and vitamins is the most effective and least expensive method of eliminating micronutrient deficiencies (WHO, 2006). Among other advantages, food fortification: is commercially viable as it retains the original nutrients and taste of food, and indeed provides the additional nutrients; cost effective as the cost to the government is minimal since the main responsibility for fortification has to be shouldered by the industry and do not require any change in dietary habits of consumers (IFIC, 2002).

In recent years, most studies have focused on reducing micronutrient malnutrition through bio-fortification (Meenakshi et al., 2010; Okello et al. 2013), with attention on breeding for enhanced nutrient content of various crops. However, the policy discourse in most developing countries, including Kenya, is shifting towards value addition in processed foods and fortification is at the forefront. Food manufacturers are also developing and marketing fortified foods in response to increasing consumer concern and interest in the link between diet and health (Zander and Hamm, 2010). However, the market for fortified foods in developing countries remains relatively small hence the need to understand what premiums are consumers willing to part with to acquire industrially fortified foods.

While studies have been carried out on preferences for food and its nutritive value (especially genetically modified foods), no study in Kenya has empirically determined willingness-to-pay for fortified sugar. This study fills this gap in knowledge through a choice experiment approach. The results can be useful for better understanding the acceptance of fortified sugar as well as the potential for food fortification in a country such as Kenya. This will also allow assessment of the possibility of using food fortification to reduce the impacts of micronutrient deficiency in developing countries.

2. Methodology

2.1. Choice experiment design

2.1.1. Definition of attributes and their levels

The starting point in CE design involved reviewing literature on the attributes and attribute levels used in previous studies and their importance in the fortified sugar-choice decisions. There are two types of attributes namely compulsory and optional attributes. The compulsory ones are those that must be observed for the fortification programme to be feasible. These compulsory features are also necessary to enforce public policy on fortification, and include monitoring for safety and quality of fortified sugar, use of non-poisonous fortificant (VA additive) as well as regulation of the type of sugar fortification programme to be adopted. The optional features offer consumers some choice and are the ones that entered the CE design. In the present study, six voluntary attributes were identified for the CE design. These are; labelling sugar as fortified, level of vitamin-A, source of vitamin A, provision of gift pack, colour of fortified sugar and price.

Focus group discussion (FGD) was conducted with stakeholders to find an easily understandable definition of what nutrition value (in this case level of vitamin A) is, and how consumption of VA could improve health. In the CE, the sugar alternatives contained varying levels of VA. These were: 5; 10; 15; with the 5 and 15-value indicating minimum and maximum levels of VA allowed by nutrition experts to be added in sugar during fortification respectively (WHO, 2006). Based on previous studies that used CE to estimate preferences for nutritional attributes (Gonzalez et al., 2010 and Birol et al, 2011), it was expected that consumers' would prefer the fortified sugar with high level of VA.

According to the results of a study by Jaeger and Rose (2008), packaging, and labelling were thought to be very important marketing traits by the highest proportion of consumers. During FGD, labelling was adopted as the marketing attribute because in Kenya sugar is already differentiated in terms of packaging, which rules out its trade-offs with other attributes. On the other hand, the gift pack attribute was defined as "packaging fortified sugar with a complementary commodity, or otherwise, as a gift (e.g., tea leaves, cocoa, coffee, etc.), to induce consumers into purchasing this commodity". The aim of including this attribute into the CE-design is to test whether certain sugar consumers need incentives to purchase fortified sugar, but with little knowledge regarding their response to this initiative.

Table 1

Hein et al., (2008) reported that taste and colour are the consumption traits that are regarded as very important by majority of consumers. Since it would be difficult to describe taste in this hypothetical context, the colour of fortified sugar was preferred. Colour was easier to describe with the help of digital technology that allowed generation of sugar cards in yellowish, brown, and white colours (see Figure 1). Finally, it is important to identify the welfare interaction effect between the attributes (Bliemer and Rose, 2010). As such, it was necessary to include price as the monetary attribute. This attribute was included in order to estimate consumers' willingness to pay (WTP) a premium for other attributes. The levels of the price attribute were derived from the prices of the sugar currently available in the Kenyan market following Birol et al. (2011).

Figure 1

2.1.2. Experimental design

The FGD recommended three levels each for three of the six fortified sugar attributes, and two levels each for the remaining three attributes. These chosen attributes and their levels produced a full factorial orthogonal main-effects design of 108 ($3^3 * 2^3 = 216$) possible fortified sugar alternatives (Adamowicz et al., 1994). The full factorial design was, in general, very large and not tractable in a CE (Huber and Zwerina, 1996). Therefore, a subset of all possible combinations was chosen, following optimality and design efficiency criteria, and then the choice sets were constructed. In CE, design techniques used for linear models were popular in the past. Orthogonality in particular has often been used as the main component of an efficient design. More recently, researchers in marketing have developed design techniques based on 'D-optimal' criteria for nonlinear models in a CE context (Huber and Zwerina, 1996). A design is said to be 'D-efficient' or 'D-optimal' if it yields data that enable estimation of parameters with sufficiently low standard errors (Kuhfeld, 2005). Bliemer and Rose (2010) noted that efficient designs generally increases sampling efficiency (reduces sampling size hence cost effective). Therefore, design efficiency implies sampling efficiency. To capture full information across the entire consumer diversity, at a reasonable sample size (considering costs constraints), an efficient criterion was adopted. Specifically, the study focused on maximizing the 'D-optimality' in two stages. In the first stage, a conventional fractional factorial orthogonal design generated from the attributes was selected and applied in a preliminary survey of 42 sugar consumers to obtain prior coefficients. The second stage involved using the 'priors' (from first stage) to generate an efficient design, whose application could estimate both main effects and interaction effects (see for example, Otieno, 2011).

The design had a relatively good level of D-optimality (i.e. D-efficiency measure of 86%). In addition, the design had good utility balance (i.e. a B-estimate of 85%)-surpassing the minimum threshold (B-estimate of 70%), which signals the fact that none of the alternatives in the choice options had any significant dominance. Worthwhile to mention is that most CE-designs rarely achieve good D-efficiency, utility balance and orthogonality simultaneously (Huber and Zwerina, 1996). Furthermore, A-efficiency of 77% implied that the variance matrix generated reliable estimates (Kuhfeld, 2005). The efficiency procedure in the NGENE (Choice Metrics, 2009) statistical software was applied to produce the design.

The final design had 24 paired choice sets that were randomly blocked into six profiles of four choice tasks. Respondents were randomly assigned to one of the six profiles.

Each choice task consisted of two alternatives (A and B) and neither option, which was the *status quo.* When making choices, respondents were asked to consider only the attributes presented in the choice tasks and to treat each choice task independently (for example, choice tasks involving higher prices never implied better quality than others and *vice versa*). An example of a choice set/card presented to respondents is shown in Figure 2.

Figure 2

2.1.3. Data and the experimental context

The target population included households residing in Western part of the country, specifically Kakamega County. Western region of Kenya was suitable for this study given that it's among the regions with the highest prevalence of VAD in the Country (Kimenju et al., 2005). The problem is exacerbated by the cereal and sugarcane dominance in the region that leads to limited dietary diversity (De Groote et al., 2010). As a result, the greater proportion of diets in these areas (communities) consists majorly of starchy staple foods with little micronutrients/limited nutritional diversity, which is the leading cause of micronutrient deficiencies (Meenakshi et al., 2010).

The sample was drawn using a two-stage sampling procedure. The first stage involved the purposive selection of Kakamega County, while the second stage involved random selection of smaller administration units within the County. The County was divided into smaller administrative units called districts. Within each district, a random sample of locations was drawn, from which a number of smaller administrative units (sub-location) were drawn, with regard to the distribution of consumers (population) within each district. Within the sub-locations, smaller units (Villages) were randomly selected, which formed the secondary sampling units.

The primary sampling units were the households and clinics, from which primary household sugar-shopper's (respondent) was drawn using a systematic random sampling criterion. To select the households, a cross-sampling method was used; that is, a cross "X" was drawn on the village map and every nth household ('n' equals five and ten where households were scattered and congested, respectively) along the "X" with a random start was interviewed (Birol et al., 2011). Where the targeted respondent was unavailable or uninterested in participating, the next randomly selected household on the list was chosen to ensure that the desired sample size was realized. Employing sampling proportionate to size criterion, a total sample size of 162 sugar consumers was interviewed. This was within the project budget and time constraints.

Prior to asking respondents to make their choices among three sugar alternatives (A, B, or the baseline option) in the four consecutive choice sets, the attributes and the choice exercise was explained slowly and clearly. The enumerators reminded the respondents that there were no wrong or right answers, and that only their honest opinion was being sought. Enumerators also reminded the respondents' that even though the choices they were going to make were hypothetical in nature, they were expected to think carefully about them, as if they were actually going to buy the sugar they selected in each choice set. In addition, the respondents were reminded that even though their choices were hypothetical (that is, even though they were not expected to buy the sugar alternative they selected), it was likely that the results of this study would inform delivery of certain types of fortified sugar in their shops. This rigorous reminder was intended to reduce the hypothetical bias that is inherent in SP studies.

2.2. Model specification

The analysis of discrete choice data with more than two unordered alternatives usually employs Multinomial logit (MNL) model. However, this model does not accommodate preference heterogeneity among consumers. The coefficients of variables that enter the model are assumed to be the same for all people, implying that different people with the same observed characteristics have the same valuation for each factor entering the model. It also imposes a restrictive assumption, independence of irrelevant alternatives (IIA) (Ben-Akiva and Lerman, 1993).

The IIA assumption states that the ratio of the probability for any two alternatives is independent of the existence and attributes of any other alternatives or it does not depend on irrelevant alternatives. A change in the attribute of one alternative changes the probabilities of the other alternatives proportionately such that the ratios of probabilities remain the same. In other words, it is assumed that the errors are independently distributed across alternatives. Furthermore, the MNL model assumes that unobserved factors are independent in situations with repeated choices for each decision maker. This substitution pattern can be unrealistic in many settings (Brownstone and Train, 1999).

A random-parameter logit model (RPL), is a generalization of the MNL model and does not exhibit the restrictive IIA property and explicitly accounts for correlation in unobserved utility over repeated choices by each respondent. It allows the parameter associated with each observed variable to vary across consumers (Train, 1998). The RPL model is a highly flexible and relaxes the three limitations of MNL models by allowing for random taste variation and hence explicitly accounting for heterogeneity in preferences; unrestricted substitution patterns; and dependence across a panel of repeated choices made by the same respondent, which captures correlation in unobserved factors that affect individual utility

Following Train (1998), the RPL coefficients are varied across the population rather than being fixed. In the specification each respondent was presented with a series of T = 4 choices. In each choice set, respondents faced a choice between J = 2 alternatives (including a baseline option). Thus, the three alternatives that the respondent faced in a particular choice set comprised two sugar fortification policy options described in terms of key design attributes (described in Table 1) and the neither option in which sugar is not fortified. The attributes of alternative j in choice occasion t faced by respondent n are collectively labelled as vector X_{jnt}. The utility obtained by individual n from alternative j in choice situation t is expressed as:

$$U_{jnt} = \beta_n X_{jnt} + \varepsilon_{jnt} \tag{1}$$

Where the coefficient vector for each respondent β_n is unobserved and varies in the population with a density function $f(\beta_n/\theta)$, while θ are the parameters of this distribution. ε_{jnt} is an unobserved random term assumed to be identically independently distributed type I extreme value. Conditional on β_n, the probability that individual n chooses alternative j in choice situation t is given by the standard MNL model:

$$L_{jnt}(\beta_n) = \frac{\exp(\beta_n X_{jnt})}{\sum_{j \in C} \exp(\beta_n X_{jnt})} \tag{2}$$

Letting *j(n,t)* denote the alternative chosen by individual *n* in choice situation *t*. The probability of individual *n's* observed sequence of choices (conditional on β_n) is simply the product of the MNL model assuming that the individual tastes β_n, do not vary over choice situations in repeated choice tasks (although are assumed heterogeneous over individuals):

$$G_n(\beta_n) = \prod_t L_{jnt}(\beta_n) \tag{3}$$

The unconditional probability for the sequence of choices made by individual n is expressed as:

$$P_n(\theta) = \int G_n(\beta_n)\ f\left(\beta_n/\theta\right) d\beta_n \tag{4}$$

Two sets of parameters are of interest in this expression: β_n is a vector of parameters specific to individual n and θ are parameters that describe the distribution of the individual specific estimates. The rationale in RPL is to estimate the θ *(*taste distribution of an individual*)*. This is usually done through simulation of the choice probability [because the integral in equation (4) is open and cannot be computed analytically]. The log-likelihood function is specified as:

$$LL(\theta) = \sum_n \ln P_n\ (\theta) \tag{5}$$

The $P_n(\theta)$ is estimated by a summation over randomly chosen values of β_n. For a selected value of the parameters θ, a value of β_n is drawn from its distribution and $G_n(\beta_n$. Repeated calculations are done for several draws and the average of the $G_n(\beta_n)$ is considered as the approximate choice probability:

$$SP_n(\theta) = \left(\frac{1}{R}\right) \sum_{r=1}^{R} G_n\left(\beta_n^{\frac{r}{\theta}}\right) \tag{6}$$

Where R is the number of draws of β_n, $\beta_n^{r/\theta}$ is the rth draw from $f(\beta_n/\theta)$ and SP_n is the simulated probability of individual n's sequence of choices. Following Train (2003), the simulation was based on Halton intelligent draws, and up to 100 draws were used in the simulations. The simulated log-likelihood function is constructed as:

$$SLL(\theta) = \sum_n \ln(SP_n(\theta)) \tag{7}$$

The approximated parameters are those that maximize SLL (θ). Trade-offs between the sugar attributes and money, i.e. the marginal willingness to pay (WTP), was computed following Hanemann (1984) as:

$$WTP = -1 \times \left(\frac{\beta_k}{\beta_p} \right) \tag{8}$$

Where β_k is the estimated coefficient for an attribute level in the choice set and β_p is the marginal utility of income given by the coefficient of the consumer's purchase behaviour. The marginal WTP (implicit price) for a discrete change in an attribute provides a measure of the relative importance that respondents attach to attributes within the sugar fortification design. Finally, the overall WTP or the compensating surplus (CS) welfare measure was obtained for three different sugar fortification policy scenarios associated with multiple changes in attribute levels as:

$$CS = \frac{-1}{\beta_p} (V_1 - V_0) \tag{9}$$

Where V_1 represents the value of the indirect utility associated with attributes of the sugar fortification scenario under consideration, whereas V_0 is the indirect utility of the baseline scenario of no sugar fortification. In this study the RPL parameters were estimated using LIMDEP version 9.0/NLOGIT 4.0, econometric software.

The variables used in the analysis of fortified sugar as well as how they were coded are given in Table 2.

Table 2

All the indicated utility parameters (variables) entered the model as random parameters assuming normal distribution, except the price attribute that was specified as fixed in order to facilitate the estimation of WTP, by eliminating the risk of obtaining extreme negative and positive trade-off values (Train, 1998).

3. Results and discussions

3.1. Socioeconomic characteristics

As shown in Table 3, more female respondents (57%) answered than males because individuals in the study areas were selected based on availability and responsibility for food purchase in the household. The implication is that female members' shoulders heavy responsibility in terms of household food purchase decisions.

Table 3

Respondents' average age is 36 years (varying from 18 to 85 years); persons younger than 18 years were not selected for the interviews as it was assumed that the younger sugar consumers had less experience in shopping and would give biased responses (De Groote et al., 2010). The mean number of years of formal education of the respondents is 10.6, with approximately 10% of the respondents having a university education. The reported high levels of education are important to nutrition information dissemination as it enhances grasp and enabled the respondents' understand the CE choice tasks during the survey (King and Meiselman, 2010).

3.2. RPL estimates

Results reported in Table 4 find consumers' on average, to prefer minimum rather than maximum level of VA, when compared to medium level. This may be explained by the fact that consumers in developing countries still show lack of confidence in food nutritional enhancements; a finding that corroborates the observations of Onyango and Nayga (2004). The results also indicate that consumers have a positive preference for the gift pack attribute, which is rational and consistent with the choice axioms of completeness and transitivity. As expected, they also prefer natural source of VA to artificial source.

The estimated coefficient for yellowish colour is negative, as expected, and highly significant. This indicates that even though consumers generally express positive willingness-to-pay for sugar fortification, they are still skeptical to changes in the sensory characteristics including colour and taste (Gonzalez et al., 2010). But, consistent with the previous studies, the preferences for food fortification programmes are higher than the dislikes of such changes in the sensory features so that fortified foods are still acceptable to the consumers.

Table 4

3.3. Willingness to pay

The negative sign and significance of the price coefficient enabled estimation of marginal rate of substitution (MRS) between the fortified sugar attributes and money. In the CE, the monetary attribute was described in terms of price for purchasing fortified sugar. Following the interpretation of Ruto and Garrod (2009), positive values indicated the price that consumers were willing to pay, trade-off or forgo in order to acquire desirable attributes. Conversely, negative values indicated the discount consumers demanded to accept less desirable attributes.

Table 5

The WTP results (Table 5) shows the relative importance assigned to each fortified sugar attribute by the consumers. Consumers are willing to pay between Kshs: 136 to 580 per kilogram for natural source of vitamin A; 144 to 496 for minimum level of vitamin A; 104 to 442 for maximum level of vitamin A; 96 to 317 for sugar to be labeled as fortified; 68 to 249 for provision of gift pack. These results compares favorably to those of De Groote, et al. (2010). They also found that Kenya consumers were willing to pay a premium of 24% for yellow biofortified maize, but were demanding a discount of 11% to accept the yellow colour. In the present case, consumers are demanding a discount of between Kshs 296 to Kshs 43 for yellowish colour in fortified sugar. The clear indication is that consumers generally prefer interventions that improve nutritional value of their food without changing its sensory characteristics. Ideally, industrial food fortification comes at a cost that consumers have demonstrated that they are willingness to pay. The positive WTP values suggest that sugar producing companies with capacities of producing fortified sugar; have a niche in the Kenyan market, with greater potential of increasing their market share.

4. Conclusions and policy implications

The growing market for enriched foods, especially fortified industrial products, provides a potential opportunity to improve the health of Kenyans and enable the development of a new value-added food sector. With the growing interest among consumers in the link between diet and health, and the credence nature of the nutritive attributes in fortified sugar, VA plays a key role in consumers' choices. The analysis employed the CE method to investigate the preferences of Kenya consumers for fortified sugar attributes considered to be most important.

Results showed that consumers were willing to pay a positive premium for all the attributes, except yellowish colour that all the consumers were demanding price discounts to accept. Heterogeneity in consumer preferences for these attributes was evidence from the higher differences in WTP estimates shown by consumers regarding all the attributes.

Future research should focus on ways of combating other micronutrient deficiencies with equally negative impacts on human health and productivity. Iron in particular, causes high economic loss especially to women. And therefore requires urgent redress in a similar manner. Policy scenarios were constructed based on dietary requirements-that was profiled using age of consumers. Understanding how preferences vary along 'societal classes' would also be important. Therefore, categorizing consumers on the basis of household income would offer additional insight.

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Table 1
Attributes included in sugar-fortification CE-design

Sugar fortification attribute	Definition of attributes	Attribute levels
Source of vitamin A	Whether vitamin A added is obtained from natural or artificial sources.	Natural Artificial
Level of vitamin A (mg / kg)	Nutrition attribute (vitamin A levels sufficient for human health according to WHO guidelines)	5 10 15
Labelling	Marketing attribute (whether sugar is labelled as fortified or not)	Yes No
Gift pack	Marketing attribute (whether fortified sugar is packed with a gift or not)	Yes No
Colour	Consumption attribute (colour of fortified sugar).	White Brown Yellowish
Price	Monetary attribute (price of 1 kilogram of fortified sugar in Kenya shillings within 50% of the current price/ status quo)	120 150 180

Table 2
Variables used in the analysis of WTP

Variable	Description
NATURAL	Source of vitamin A used is natural (1= yes; 0= otherwise)
MIN	Minimum level of vitamin A added – 5ml/kg (1= yes; 0=otherwise)
MAX	Maximum level of vitamin A added - 15ml/kg (1= yes; 0= otherwise)
LABEL	Sugar packet is labeled as fortified (1= yes; 0= otherwise)
GIFT	Gif- pack is provided (1= yes; 0= otherwise)
BROWN	Colour of fortified sugar is brown (1= yes; 0= otherwise)
YELLOWISH	Colour of fortified sugar is yellowish (1= yes; 0= otherwise)
PRICE	Cost of purchasing1kg of fortified sugar (120, 150 or 180)

Table 3
Socioeconomic characteristics of the respondents

Variable	**Descriptive**
Average age of respondent (years)	36.4(12.2)
Average household income (Kshs)	23700(18898)
Average household size	5.1(2.7)
Average Years of schooling completed	10.6(3.6)
Gender of respondent (% Female)	56.8
Aware of VA fortified sugar (% Yes)	46.3
Have consumed fortified sugar (% Yes)	29.0
Household has at least one member below 5 yrs. (% Yes)	58.6
Frequency of consuming sugar (% Daily)	97.5
Usually read labels while buying sugar (% Yes	31.5

* Standard deviations are in parentheses (for continuous variables).

Table 4
RPL estimates for fortified sugar attributes

Variable	Estimate
NATURAL	2.61 (0.53)***
MIN	2.46 (0.55)***
MAX	2.10 (0.53)***
LABEL	1.59 (0.33)***
GIFT	1.22 (0.3)***
BROWN	2.46 (1.35)*
YELLOWISH	- 1.31 (0.38)***
PRICE	- 0.008 (0.003)**
Standard deviations of parameter distribution	
sdNATURAL	1.95 (0.48)***
sdMIN	2.78 (0.75)***
sdMAX	0.18 (0.38)
sdLABEL	1.12 (0.49)**
sdGIFT	0.76 (0.39)**
sdBROWN	0.39 (2.55)
sdYELLOWISH	0.50 (0.50)
Log-likelihood	- 448.34
Pseudo-R^2	0.37

Notes: Statistical significance levels: *** 1%; ** 5%; * 10%. Corresponding standard errors are shown in

Table 5
Marginal WTP estimates for fortified sugar-attributes (Kshs)

Variable	Marginal WTP (95% confidence interval) WTP Estimate
NATURAL	340.0 (135.5 to 580.4)
MIN	319.8 (143.6 to 496.0)
MAX	273.2 (104.3 to 442.1)
LABEL	206.6 (95.9 to 317.2)
GIFT	158.8 (68.4 to 249.1)
BROWN	320.2 (- 61.2 to 701.7)
YELLOWISH	- 169.9 (- 296.4 to – 43.4)

Notes: Marginal WTP estimates are significant below the 1% level.

Figure 1
Illustration of colour attribute

Source: Authors' survey card

Figure 2
Example of fortified sugar choice set

	Sugar type A	Sugar type B	Neither type A or type B
Source of vitamin A	Artificial	Natural	
Level of vitamin A	10	10	
Labelling	Labeled	Not labeled	
Gift Pack	No gift pack	Has gift pack	
Colour	White	Yellowish	
Price	120	180	
Which ONE would you prefer?			