Public Acceptance of and Willingness to Pay for Nanofood: Case of Canola Oil

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Abstract

Nanotechnology has tremendous potential in food and agriculture. Few economic studies focused on specific products made using nanotechnology, let alone food or food related products. Using a national choice experiment survey, this analysis examines consumers' valuations for nano-attributes. As implied, consumers were willing to pay less for canola oil if it was produced from nanoscale-modified seed; less if the final products were packed with nanotechnology-enhanced packaging technique; and no significant difference was found for oil that was designed with health enhancing nano-engineered oil drops, which would require interaction with the human digestive system. Additionally, the results revealed unobserved heterogeneities among respondents in their willingness-to-pay for canola oil attributes. Findings from this study will help bridge the gap between scientific innovation and public policy and social-economic concerns. Implications for government policy that can be efficiently used to monitor and regulate these technologies were also investigated.

Keywords:

Choice experiment, Mixed Logit model, Nanotechnology application, Willingness to Pay,

JEL Code: Q13, Q16

Introduction

Science in agricultural development has brought real benefits to farmers, processors and consumers through the development and implementation of new knowledge and technology over the past decades. New food technologies enable a new era of agriculture and food systems by bringing innovative applications, improving agricultural productivities. So far, nanotechnology has been no exception. In food science, nanotechnology seems to provide a sound framework to understand the interactions and assembly behavior of food components (Sangunsri and Augustin, 2006) in microscopic scale, which may influence food structure, rheology and properties in counterpart bulk form. Nanotechnology has already begun to attract the attention of investors, media and policy makers. Progress among researchers continues to grow. Meanwhile, the public demands to be informed and involved in decision making about the technology (Macoubrie, 2005), especially when billions of tax dollars are invested in nanotech research and development. Therefore, it is crucial for policy makers and other stakeholders to have a good grasp of public opinion in this relatively early stage of nanotechnology development.

Previous studies have examined public understanding and perception of general nanotechnology via surveys in the US, Canada, or both (Cobb and Macoubrie, 2004, Currall, et al., 2006, Einsiedel, 2005, Hart, 2009, Macoubrie, 2005, Priest, 2006, Smith, et al., 2008). Their results suggested that consumers' knowledge about nanotechnology is generally limited, and even more so for food-relevant nanotechnology. Yet, their initial reaction to this technology is generally positive, which may encourage additional applications and final products' commercialization in the future. Hence, qualitative and quantitative research about this new technology is necessary for future market success.

A survey conducted in Switzerland found that nanotechnology food packaging was assessed as less problematic than nanotechnology food (Siegrist, et al., 2007). Another recent survey carried out in Germany (Roosen and Bieberstein, 2011) evaluated participants' willingness to pay (WTP) for food produced using nanotechnology. Results implied that health information offered to consumers while they were making a purchase was a priority and significantly decreased WTP. However societal and environmental information did not significantly influence WTP. Although these results to some extent showed consumers' recognitions to nanotechnology, little has been done to assess consumers' acceptance of different nanotechnology applications of food, especially in the US. The objective of our study and survey is to empirically estimate consumers' acceptance of nanotechnology techniques, particularly when applied to food products in different sectors: production, packaging and final products. To our knowledge, the results from our study provide a key contribution as the first choice-based conjoint analysis of consumer preference and the first systematic survey for food related nanotechnology.

Background

Scientists and industry have already used nanotechnology to bring advances into many segments of the food industry, from ***agriculture***(e.g. precision farming and nanosensorsto monitor production; smart delivery systems; water development; etc.), to f***ood processing*** (e.g. encapsulation technique for better flavor and odor; food texture or quality improvement; etc.), to ***food packaging*** (e.g. UV-protection; stronger, more impermeable polymer film; smart food wrapper), and to ***nutrition supplements*** (e.g. nutraceuticals with vitamin enhancement; natural molecular clusters in food item; etc.) (Duncan, 2011, ETC, 2004, HelmutKaiserConsultancy, 2006, Hillie, et al., 2006, Joseph and Morrison, 2006, Kuzma and VerHage, 2006, Miller and Senjen, 2008). Generally, nanotechnology is employed for many current and potential food applications.

The Project on Emerging Nanotechnologies (PEN), which is sponsored by both the Woodrow Wilson International Center for Scholars and the Pew Charitable Trust, compiles and publishes an online inventory of nanotechnology-based consumer products currently marketed worldwide on an ongoing basis. This searchable PEN inventory is not comprehensive, and listed items claimed by manufacturers rather than certified by an independent third party as an actual use of nanotechnology. Nevertheless, it is believed to be the most accurate account of commercialized nanotechnology applications. For the purpose of this study, we examine and summarize only consumer products in the category of food and agriculture. A total of 105 food or food related products were listed under this category through March 2011, the most recent release date. Four subcategories are included: cooking supplies, food, storage and supplements. However, agricultural products are not obvious in this inventory.

Duncan (2011) suggested another classification by dividing these consumer products into four groups: agriculture, food processing, food-related products and nutrition products. In line with above research, we assembled all different techniques applied in agriculture and food in this study, but into three groups: ***NanoAgriculture***, ***NanoPackaging***, ***Nanodrops***. We use canola oil as the carrier product throughout the survey. The three types of nanotechnology may be relevant to canola oil production as follows: (A) Canola seeds might be produced under nanomonitoring in that water, fertilizer, or pesticide may be applied more efficiently and therefore reduces production cost and improve environmental quality. We refer to this technology as ***NanoAgriculture***. (B) Canola oil bottle may be produced through nanotechnology to keep canola oil fresh for a longer period of time and to alert consumers if the quality of oil starts to deteriorate. We refer to this technology as ***NanoPackaging***. (C) Nanodrops may be added to canola oil to block cholesterol from being absorbed by human digestive system. We refer to this technology as ***NanoDrops***. We refer to the three attributes as nano-attributes hereafter and all of these are indicator variables that are valued at one if the corresponding attribute is present, and zero otherwise.

Survey Description

We conducted a nationwide online survey that targeted typical US consumers. The choice experiment (CE) embedded in the survey enables elicitation of WTP associated with different nanotechnologies pertaining to agriculture and food. The CE attributes were adopted from previous literature and from PEN inventories as discussed previously. The survey contained six sections. The first two sections contain basic questions on consumption habits for general canola oil and beliefs about food technology applied to food items, which were designed to attract consumers' attestations in the beginning of the survey (Dillman, 2000). The third section contains the choice experiment, where each respondent was randomly shown eight choice sets out of a total of sixteen. Figure 1a and 1b present an example, where the definition refers to the description mentioned previously. The last two sections of the survey questionnaire include questions about consumer perception and attitude toward nanotechnology in general and some demographic information. The sample screened only adult consumers. Descriptive statistics are provided in Table 1. Demographics compare closely to the US Census, which indicates the sample is reasonably representative.

In the choice experiment, besides nano-attributes mentioned previously, NONGMO was also included as an attribute indicating the food item was produced, packaged, and/or delivered without being contaminated by any genetically modified organisms. This attribute was a dummy variable as well. Lastly, four price levels were used according to market research of typical canola oil (in a 48-ounce bottle): $2.99, $5.99, $8.99 and $11.99. These levels allow us to empirically compare the utility associated with each of the attributes. From these, implications could be drawn about which attributes were most accepted and valued by consumers. All levels and attributes were introduced in Table 2. In order to reduce respondents' burden, the fractional factorial design was adopted. It yielded 16 possible combinations (or choice sets) and was blocked into 2 groups. Each respondent was assigned randomly to one group during the survey.

Model and Specification

Logit models have been widely used to estimate choice experiment data, including both conditional logit (CL) and mixed logit model (ML) (Erdem and Rigby, 2011, Hu, et al., 2005, Lim, et al., 2012, Lusk and Sullivan, 2002, Roosen, et al., 2011, Teratanvat and Hooker, 2006). The models follow the (RUM) Random Utility Model framework (McFadden, 1974), such that utility U_{ijt} associated with respondent *i* for alternative *j* in choice set *t* is a linear function of observable vector of attributes $\boldsymbol{X}_{ijt}$ with remaining unobservable component represented by ε_{ijt}, as follows:

$$U_{ijt} = V(\boldsymbol{X}_{ijt}\boldsymbol{\beta}) + \varepsilon_{ijt}$$

The solution will be defined through maximization: individual *i* will choose choice *j* if and only if he/she obtains higher satisfaction by this choice among all other alternatives in a choice set, or mathematically, $U_{ij} > U_{im}\ for\ all\ m \neq j$. Therefore, this model provides a set of parameter weights on the attributes that maximizes the likelihood of realizing the observed choice, and the choice probability of alternative *j* chosen in choice set *t* by individual *i* is given as:

$$\pi_{ijt} = \frac{exp(\boldsymbol{X}_{ijt}\boldsymbol{\beta})}{\sum_{k=1}^{J} exp(\boldsymbol{X}_{ikt}\boldsymbol{\beta})}$$

The mixed logit model assumes that coefficients in vector $\boldsymbol{\beta}$are random parameters, allowing variations across individuals. Then the mixed choice probability becomes (Greene, 2000, Train, 2003):

$$\pi_{ijt} = \int \frac{exp(\boldsymbol{x}_{\boldsymbol{ijt}}\boldsymbol{\beta})}{\sum_{k=1}^{J} exp(\boldsymbol{X}_{ikt}\boldsymbol{\beta})} h(\boldsymbol{\beta})d\boldsymbol{\beta}$$

, where $h(\boldsymbol{\beta})$ is the mixing distribution, which is specified as normal in this study.

In both CL and ML, the observable component can be expressed according to our specification in this study:

$$V_{ijt} = \alpha * \text{price}_{\text{ijt}} + \boldsymbol{X}_{ijt}\boldsymbol{\beta}$$

$$\boldsymbol{x}_{ijt} = [BUYNO, NANOAG, NANOPACK, NANODROPS, NonGMO]_{ijt}$$

The price level variable $price_{jt}$ along with its parameter α, which is specified as fixed to avoid an unrealistic positive coefficient associate with price (Meijer and Rouwendal, 2006, Olsen, 2009). Consistently, the choice probability is now:

$$\boldsymbol{CL}: \pi_{ijt} = \int \frac{exp\left(\alpha * \text{price}_{\text{ijt}} + \boldsymbol{x}_{ijt}\boldsymbol{\beta}\right)}{\sum_{k=1}^{J} exp\left(\alpha * \text{p}_{\text{ijt}} + \boldsymbol{x}_{ijt}\boldsymbol{\beta})\right)} d\boldsymbol{\beta}$$

$$\boldsymbol{ML}: \pi_{ijt} = \int \frac{exp\left(\alpha * \text{price}_{\text{ijt}} + \boldsymbol{x}_{ijt}\boldsymbol{\beta}\right)}{\sum_{k=1}^{J} exp\left(\alpha * \text{price}_{\text{ijt}} + \boldsymbol{x}_{ijt}\boldsymbol{\beta}\right)} h(\boldsymbol{\beta}) d\boldsymbol{\beta}, \text{where } \boldsymbol{\beta} \sim Normal(\boldsymbol{\theta}, \Omega)$$

The marginal value or WTP for an attributes is given by the ratio of the attribute coefficient to the price coefficient which is set to be fixed as above, such that:

$$\text{WTP}_{\text{j}} = -\frac{\beta_j}{\alpha}$$

$$\text{j} = [\text{BUYNO, NANOAG, NANOPACK, NANODROPS, NONGMO}]$$

The calculation of WTP contains fixed coefficient α and random coefficients $\boldsymbol{\beta}$. In ML estimation, results report ***distributions*** for not only mean but also standard error for $\boldsymbol{\beta}$. Based on the model result, the standard errors of WTP measures incorporate both mean and standard deviation results, which provides a better description of WTP distribution. An alternative approach is to report distribution of the WTP as the distribution of the attributes or interactions coefficient scaled by the fixed price coefficient, rather than a single representative WTP when demographics and other factors are held at the sample average levels (Hole and Kolstad, 2012).

Estimation Results

The results of CL and ML models are provided in Table 3 and Table 4. The log-likelihood scores attest to how well the model explained the variation in the data. As a result, the ML model is more efficient than CL model (Log Likelihood= -9415.447 in CL and -7785.278 in ML). Four ($\sigma_{BUYNO}, \sigma_{NonGMO}, \sigma_{NANOAG}, \sigma_{NANODROPS}$) out of five of the standard deviations of the random coefficients are strongly statistically significant at the 1% level, which suggests stronger explanatory power for the ML model compared to the CL model. Other model fitness criteria are also given in both tables: Pseudo/Adjusted McFadden R^2, AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion). As depicted, Pseudo R^2 is higher in the ML model suggesting higher explanatory power; both AIC and BIC are smaller in ML model indicating better fit to the data.

In the CL model, all coefficients are statistically significant at least at the 5% significance level, except for the coefficient for variable NANOPACK. The interpretation is straightforward: if not choosing any of the canola oil (where BUYNO=1) consumers' utility is reduced; a negative association is observed between price and canola oil products; consumers strongly preferred product without GM ingredients or GM contaminated as the coefficient for NONGMO is strongly positive; coefficients for Nano-attributes were different from each other. The coefficient for NANOAG is significant and negative, indicating that consumer did not prefer canola oil produced with nanotechnology. NANOPACK is not significantly different from zero, indicating that consumers valued the canola oil relatively the same, either with or without nanotechnology package. However, a significantly positive relationship was observed between consumers' utility and the NANODROPS attribute, implying the functional benefits underlying this attribute drew attention from consumers and they valued it positively. WTP estimates based on the CL model are also provided in the last column in the Table.

Next, a mixed logit model was estimated with random coefficients for BUYNO, NONGMO, and three Nano-attributes (NANOAG, NANOPACK, NANODROPS) following normal distributions and the coefficient for price being fixed. The result is shown in Table 4. Recall, the fit of the ML model was improved from the CL model, with a lower absolute value of log likelihood and a larger pseudo R^2 (or, McFadden R^2) (Domencich and McFadden, 1975). A total of 500 Halton draws were used per iteration in the simulated maximum likelihood estimator (Train, 2003). ML results were in line with previous CL results to the large extent. Would-not-buy option and price levels were observed negatively associated with consumers' utility. The NONGMO feature was again preferred.

All signs for the coefficients of nano-attributes remained the same as before, but the significance changed slightly. For example, the coefficient for NANOAG was 1% statistically significant and negative; however, NANOPACK became significant; and insignificant for NANODROPS. Most standard deviation estimates were strongly significant at the 1% significant level, except for the coefficient of NANOPACK. This reveals the flexibility of the ML model compared to the CL model. Meanwhile, standard deviations imply taste variations across individuals. Therefore, significant heterogeneities were shown according to the results in ML model.

From mean and standard deviation estimates of a normally distributed coefficient, one can calculate the share of respondents in the sample who held a positive or a negative view on that attribute through the normality function $\beta \sim Normal(b, \sigma^2)$. If half of the consumers hold a strong positive view on an attribute but the other half negative, the attribute would be insignificant in a conventional CL model. In that case, respondents' perceptions were equally clustered on both sides of zero, where the average effect is reported by CL model. Given all information provided in ML model in Table 4, the share of consumers who value each random coefficient attribute are provided in Table 5.

A total of 74.9% of the respondents had negative values for the Would-not-buy option, indicating a majority of the respondents would like to buy a canola oil product instead of buying nothing. From the mean estimate for the coefficient of NONGMO in the ML model, the sampled respondents preferred canola oil if it was not GM related. However, around 43.6% held a negative opinion on this attribute, indicating that consumers may accept the GM feature, and were unwilling to pay more for oil that avoided fortified GM ingredients.

ML model results indicated negative association between the attribute NANOAG and consumers' utility, with significant underlying heterogeneity. It also showed a significantly negative influence for the attribute NANOPACK. However insignificant heterogeneity was observed across the sampled individuals. Lastly, the attribute NANODROPS was insignificant in affecting canola oil purchase, although significant heterogeneity existed. Furthermore, the splits between positive and negative for the normally distributed coefficients for nano-attributes, displayed in the rest of Table 5, served to explain in more detail preference variations. For instance, *ceteris paribus*, 55.6% of the respondents did not prefer the NANOAG attribute designed for canola oil where nanotechnology may be adopted during the cultivation or production of canola seeds; however, the rest 44.4% of the sample viewed it positively. Second, slightly more than half of the respondents (52.8%) held a negative view for attribute NANOPACK, where the canola oil may be bottled or stored in a container with nanotechnology. Third, the attribute NANODROPS (fortified nanodrops added to canola oil to block cholesterol from being absorbed by human digestive system) was preferred by more than half of the surveyed consumers (51.2%).

These results indicated that consumers behaved differently for new technology applied to food products, either the GM or nanotechnologies. Underlying driving forces for these heterogeneous preferences could be related to consumers' different characteristics including demographics, food shopping habits, risk perception, and general acceptance of new technologies. More exploration could be explored in future work.

Table 6 introduces the willingness-to-pay estimates on the basis of the results from the ML model. They were calculated by the nonlinear combination function provided in Stata, using command *nlm* and referring to the expression for WTP_j. The second column depicts the results of the WTP for each attribute, which is the ratio between the marginal utility obtained from that attribute and the coefficient of price. On average, individual would lose $11.73 if he/she did not buy any canola oil in the scenario. Moreover, consumers were likely to pay an average of $0.99 more for a typical bottle (48 fl. oz.) with the NonGMO attribute. Consumers would be willing to pay $0.95 less per bottle if the canola seeds were produced with nanotechnology. Similarly, consumers would be willing to pay $0.51 less for canola oil packed in a bottle produced with nanotechnology. However, the willingness to pay estimate for the attribute NANODROPS is not significantly different from zero, with a 99% confidence interval of [-$0.23, $0.76].

Conclusion and Implications

Using a choice experiment, this study investigated consumers' valuation of canola oil with different types of nanotechnologies applied, as well as in comparison to genetically modified features. The results indicate that NONGMO significantly increased the value of a product, however, the three different nano-attributes didn't show consistent results. These details are one of the benefits brought by investigating differentiated techniques (e.g. NanoAgriculture, NanoPackaging, NanoDrops). The study attempted to find out how different branches of technologies might affect consumers' choices and how much consumers valuate these features. Two logit models were utilized, while the mixed logit model reveals the existence of substantial heterogeneity in consumers' tastes on various attributes, including NONGMO and three nano-attributes (NANOAG, NANOPACK, NANODROPS). Estimates for the coefficients in the CL model and estimates for the mean of the random coefficients in the ML model are generally consistent. Consumers valued attribute NANODROPS positively and higher than other nano-attributes. In fact, consumers did not distinguish between attribute NANOAG and attribute NANOPACK. A plausible explanation could be that consumers might have become positive towards nanotechnology when they were aware of the explicit benefits of nanotechnology. The results indicated that it may be more beneficial for food producers to adventure the potentials that nanotechnology could bring to enhance the well being of consumers.

This study examines how US consumers may prefer and value various attributes associated with new food technologies, especially nanotechnologies. Given that the majority of past studies on nanotechnology have focused on its general applications, this study provides a timely contribution to the understanding as it is applied to agriculture and food. The willingness to pay valuation with an application of the choice experiment provides a valuable guidance for understanding societal support for food nanotechnologies. As suggested in the results, the number of consumers who were positive toward non-genetically modification was greater than the number of consumers who had negative attitudes. Marketers and policy makers can learn from the results of this study to assist better marketing and regulation of nanofoods.

Consumers response toward the three branches of nanotechnologies: nanoagriculture, nanopackaging and nanodrops, shows their initial recognitions of this new technology. The spilt results in consumer responses towards the three branches of nanotechnologies highlighted the importance to understanding the varying implications of different types of nanotechnologies. According to this analysis, consumers would like to pay more for nanodrops when they know its functional benefit. Findings from this study will help bridge the gaps between scientific innovation, application of nanotechnology, public policy and industry development. A marketer may consider focusing more on products that would bring direct benefits to human health and may adjust the distribution and merchandising strategy accordingly. Industry producers and marketers should note different consumers may place different values for attributes associated with food nanotechnology. Furthermore, implications from this study could be helpful for scientific development of nanotechnology to discover more practical outlets.

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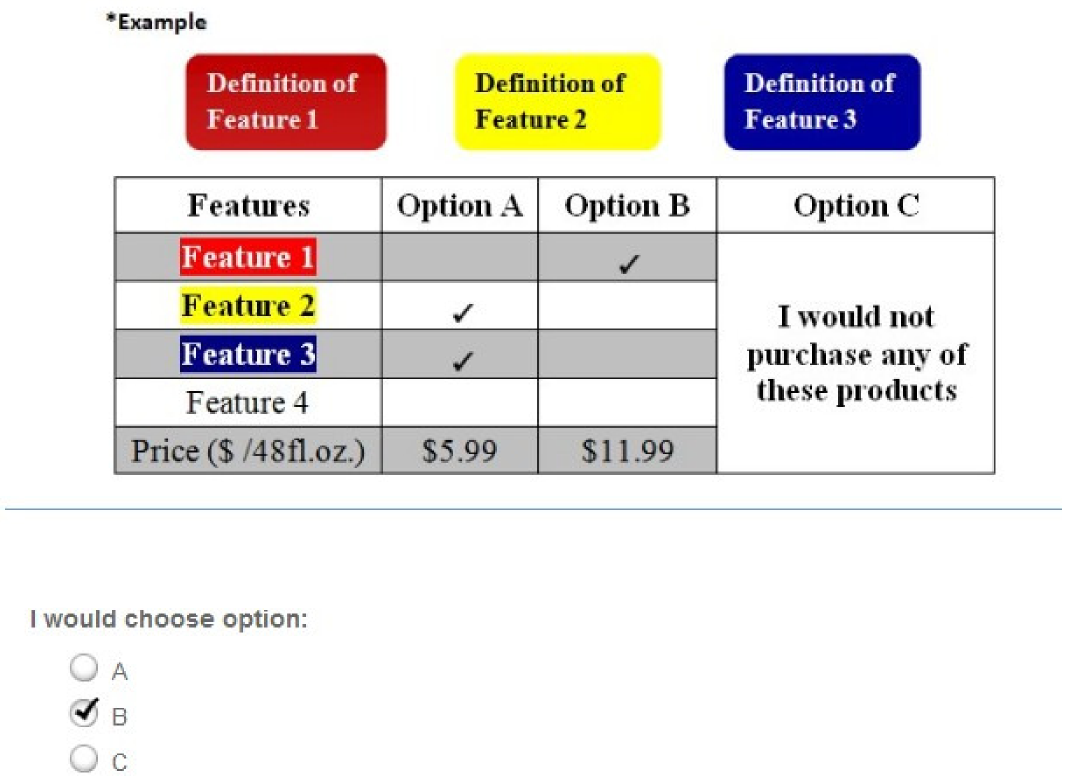

*Example

Definition of Feature 1

Definition of Feature 2

Definition of Feature 3

Features	Option A	Option B	Option C
Feature 1		✓	I would not purchase any of these products
Feature 2	✓		
Feature 3	✓		
Feature 4			
Price ($ /48fl.oz.)	$5.99	$11.99	

I would choose option:

- A
- B
- C

Figure 1a Choice Scenario Example

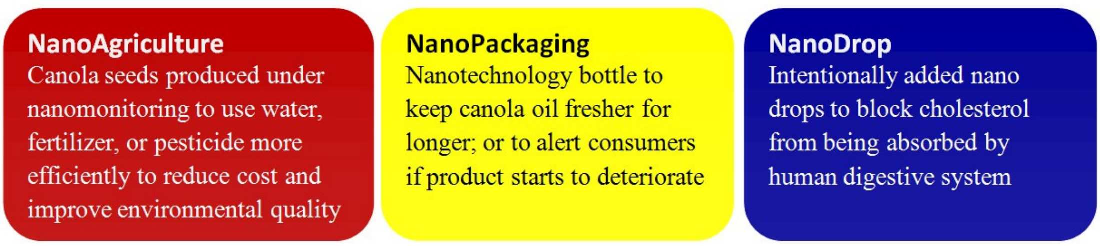

Figure 1b Choice Scenario Example

Table 1 Sample Demographic

Variable	Group	Percent	Sample Mean	US Census
Household size			2.66	2.55[a]
Age			40.76	37.2[b]
Education	Never Attend School	0.27%		0.36%
	Less than 9th grade	0.09%		4.24%
	9th to 12th grade, no diploma	1.77%		8.58%
	High School graduate	15.74%		30.01%
	Post secondary trade or technical school certificate/Degree	5.84%		4.00%
	Some college, no degree	24.58%	15	19.46%
	College Diploma/Degree	20.42%		23.59%
	University undergraduate degree	7.25%		
	Some Post Graduate University	5.57%		
	Post Graduate Degree(e.g. master or PhD, or other professional degrees)	17.60%		9.76%
	Decline to Response	0.88%		
Male	Male	56.03%		0.49[b]
	Female	43.97%		
Marriage Status	Married	45.78%	0.46	
	Others	54.22%		
Household Income				51.42 k[b]
	Less than $20000	14.68%		
	$20000~$29999	11.05%		
	$30000~$39999	11.76%		
	$40000~$49999	10.43%		
	$50000~$59999	8.93%		
	$60000~$69999	7.34%	65.16 k	
	$70000~$79999	7.34%		
	$80000~$89999	4.69%		
	$90000~$99999	5.22%		
	$100000~$200000	15.03%		
	More than $200000	3.54%		
Community	City	32.80%		
	Suburb	42.68%		
	Small Town	13.62%		
	Countryside or Rural Area	10.96%		

[a] US Census

[b] Current Population Survey 2012 Annual Social and Economic Supplement, formerly known as the March Supplement.
http://www.census.gov/hhes/www/cpstables/032012/hhinc/hinc01_000.htm

Table 2 Attribute Levels and Descriptions

Attributes	Levels	Variables	Descriptions
Price ($/per 48 fl.oz.)	$2.99 $5.99 $8.99 $11.99	PRICE	Refers to canola oil price in retail grocery store where the respondents typically shops
Nano-attributes			
Nanopackaging	YES NO	NANOPACK	Refers to nano-attributes definitions
NanoAgriculture	YES NO	NANOAG	
NanoDrops	YES NO	NANODROPS	
Non-GMO	YES NO	NONGMO	Means the canola oil was produced without GMO contaminated
Would-not-buy	YES NO	BUYNO	Alternative option

Table 3 Conditional Logit Model Results

Variables	Coeff		Std. Err.	P Value	[95% Conf.	Interval]	WTP
BUYNO	-0.9090	***	0.0477	0.00	-1.0025	-0.8156	-$7.33
PRICE	-0.1241	***	0.0046	0.00	-0.1330	-0.1152	--
NonGMO	0.1318	***	0.0326	0.00	0.0680	0.1957	$1.06
NANOAG	-0.0644	**	0.0292	0.03	-0.1215	-0.0072	-$0.52
NANOPACK	-0.0174		0.0298	0.56	-0.0758	0.0411	(-$0.14)
NANODROPS	0.0646	**	0.0271	0.02	0.0114	0.1178	$0.52
Log Likelihood	-9415.447						
Adjusted Pseudo R^2	0.0421						
AIC	18842.890						
BIC	18892.080						

and * represent significant at the 5% and 1% significance levels respectively.

Table 4 Mixed Logit Model Results

Variables	Coeff		Std. Err.	P Value	[95% Conf. Interval]	
MEAN						
BUYNO	-1.8658	***	0.1133	0.00	-2.0879	-1.6437
PRICE	-0.1590	***	0.0060	0.00	-0.1707	-0.1473
NONGMO	0.1567	***	0.0404	0.00	0.0777	0.2358
NANOAG	-0.1509	***	0.0455	0.00	-0.2400	-0.0618
NANOPACK	-0.0809	**	0.0373	0.03	-0.1540	-0.0077
NANODROPS	0.0422		0.0400	0.29	-0.0361	0.1205
Std Dev						
BUYNO	2.7847	***	0.1128	0.00	2.5636	3.0059
NONGMO	0.9782	***	0.0612	0.00	0.2063	0.5745
NANOAG	1.4460	***	0.0634	0.00	0.8075	1.0394
NANOPACK	1.1501		0.0592	0.79	-0.2192	0.1671
NANODROPS	1.2438	***	0.0606	0.00	0.6688	0.8854
Log Likelihood	-7785.278					
Adjusted McFadden $R^{2\,a}$	0.1728					
AIC	15592.56					
BIC	15682.73					

** and *** represent significant at the 5% and 1% significance levels respectively.

[a] is obtained by using one minus the ratio between the adjusted unrestricted and restricted log likelihood function values.

Table 5 Positive/negative shares of attributes with random coefficients

	Percentage (%)	
Coefficient	**Positive**	**Negative**
BUYNO	25.1%	74.9%
NONGMO	56.4%	43.6%
NANOAG	44.4%	55.6%
NANOPACK	47.2%	52.8%
NANODROPS	51.2%	48.8%

Table 6 Willingness-to-Pay from Mixed Logit Model Results

Variables	Coeff		Std. Err.	P Value	[95% Conf. Interval]	
BUYNO	-$11.73	***	$0.68	0.00	-$13.07	-$10.39
NONGMO	$0.99	***	$0.26	0.00	$0.49	$1.49
NANOAG	-$0.95	***	$0.29	0.00	-$1.51	-$0.39
NANOPACK	-$0.51	**	$0.23	0.03	-$0.97	-$0.05
NANODROPS	$0.27		$0.25	0.29	-$0.23	$0.76

** and *** represent significant at the 5% and 1% significance levels respectively.