Experimental Determination of Canadian Consumers' Willingness-to-pay for Meat Packaging

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Abstract

The main objective of this paper is to identify factors that determine consumers' purchase decisions for ground beef offered with different packaging technologies such as modified atmosphere packaging. Consumers' increasing knowledge about food technologies and changes in food labeling regulation influences agribusiness' future product development and marketing strategies. Choice experiments with ground beef, conducted in Alberta, Canada are used to quantify consumers' valuation of technology-related attributes, namely shelf life, colour and packaging. How alternative types of information and labeling, respectively, affect consumers' WTP is of particular importance to processors but as well to food safety analysts. Results aim to benefit food producers and retailers who make decisions about investing in new packaging methods, food control and food safety.

Key Words: choice experiments, willingness to pay, modified atmosphere packaging, ground beef

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1. Introduction

Nowadays, consumers express concerns about and demand healthy and safe meat products, as well as products that meet higher quality standards and are more convenient to use. In this context, keeping colour attractive is of primary importance since colour is one of the first attributes consumers use to evaluate overall meat quality (GREBITUS, 2008). Colour plays a major role in influencing purchase decisions (VIANA ET AL., 2005). In purchasing fresh meat in a retail environment, colour has a significant impact on consumers' quality expectations and especially freshness expectations, even if the colour does not affect taste or shelf life (SØRHEIM ET AL., 2001).

While meat colour is very important, establishing a bright cherry red colour and maintaining it during retail display is still a challenge. Improved but still limited colour stability is achieved by packaging meat in a modified atmosphere. This so-called modified atmosphere packaging (MAP) refers to the replacement of air in the package with a single gas or a mixture of gases such as a high oxygen (O_2) atmosphere, of at least 60% O_2 (SØRHEIM ET AL., 2001). Another gas used to preserve meat colour is carbon monoxide (CO) in concentrations between 0.3% and 0.5%. This gas strongly binds myoglobin to form carboxymyoglobin, producing a stable bright red colour to the muscle meat. MAP with low concentrations of CO and high concentrations of carbon dioxide (CO_2) has been shown to improve beef and pork colour. Additionally, MAP extends shelf life (VIANA ET AL., 2005). Overall, MAP is commonly used to maintain and improve the quality of foodstuffs.

Advantages of MAP containing CO (MAP/CO) for consumers are stable and attractive colour, increased shelf-life and little or no need for the use of chemical preservatives. Food producers might benefit due to the reduction in distribution costs as there are fewer deliveries over longer distances and less waste. Meat colour changing from cherry red to grey reduces revenue because the meat would be sold cheaper or have to be discarded as no longer accepted by consumers. But, retailers might question the contribution of the added cost of packaging (PHILLIPS, 1996). Hence, investigating consumers' willingness to pay (WTP) for MAP and MAP/CO supports improved decisions by food producers and retailers, as well as analysts concerned about the benefits and value of the new technology for consumers.

MAP and MAP/CO do have other effects on food safety – both actual and perceived. Regarding food safety, growth of spoilage and pathogenic bacteria are generally reduced by using MAP with increased levels of CO_2 and/or removal of O_2 (SØRHEIM ET AL., 2001). Nevertheless, several consumer groups claim that use of MAP/CO has negative effects on consumers' health, because it could mask spoilage since CO stabilizes the meat colour longer than the shelf-life. There is a certain risk that pathogens such as *Listeria Monocytogenes* grow while fresh colour is maintained. Consumers who do not pay attention to the expiration date might be at risk (PHILLIPPS, 1996).

Against this background, consumers' stated preference and WTP for colour, shelf life and packaging technologies are analyzed. Using choice experiments this paper reveals how these characteristics affect retail ground beef prices in Canada.

We investigate consumer response towards ground beef packaged with MAP and particularly CO as the colour stabilizer in MAP. MAP is an innovative technology. While in scientific literature many studies exist on technological effects and characteristics of MAP (e.g. CLIFFE-BYRNES AND O'BEIRNE, 2005; ALLENDE ET AL., 2004; ROCCULI ET AL., 2004; JAYAS AND JEYAMKONDAN, 2002), there is no economic assessment of consumers' preferences regarding MAP and MAP/CO. To our knowledge, this is the first study of consumers' WTP for shelf life extension and colour stabilization of ground beef resulting from MAP and MAP/CO under different information and labelling scenarios. We develop a data set based on an experimental, consumer-based study and apply mixed logit models to analyze the data. This analytical approach provides a flexible econometric method for economic discrete choice that is postulated to come from utility maximization (e.g. MCFADDEN AND TRAIN, 2000). Finally, marketing recommendations for the agribusiness can be derived.

The remainder of the paper is as follows. Section 2 gives an overview regarding previous research. Section 3 describes the methodology. Section 4 presents the results and section 5 concludes.

2. Previous research

A number of empirical studies contributed to the better understanding and evaluation of the retail value of major meat product attributes. For example TONSOR ET AL. (2005) used choice experiments to investigate consumer preferences for beef steak attributes in Europe. The study confirms that consumers are on average willing to pay a premium for a labelled steak (USDA Choice No Hormones or GMOs) as opposed to their "Domestic Typical" steak. NAYGA ET AL.

(2005) used choice experiments in U.S. grocery stores to measure consumers' WTP for irradiated ground beef. In 2004, irradiation of retail meat products was a new technology that created public discussion and concern; today, other technologies such as MAP, the subject of our analysis, are at the center of some controversy.

With respect to colour, ALFNES ET AL. (2006) studied Norwegian consumer preferences for different salmon colours using non-hypothetical choice experiments. Participants were informed about the nature of salmon colouring (e.g. for farmed salmon, synthetically produced astaxanthin is added to the feed). Results revealed that consumers use colour as a quality indicator and are willing to pay more for salmon fillets with normal or above-normal redness, as compared to paler fillets. Additional consumer information about the salmon colour did not affect the WTP for pale and normal red fillets but consumers' WTP for above-normal red fillets decreased. This indicates a weak reaction to labeling and response to information, when product appearance remains in boundaries perceived to be "natural".

This paper extends the experiments by ALFNES ET AL. (2006) and examines consumer response to MAP and MAP/CO technologies by including shelf life as an additional, third choice attribute. Unlike the ALFNES ET AL. study, we use three, instead of five-level attributes, because we have an additional attribute and needed to avoid a design that is too large. Also, in contrast to ALFNES ET AL. we use photographs instead of real products, as MAP/CO is forbidden in Canada.

3. Methodological background

The main objective of this research project is to measure the premiums consumers are willing to pay for shelf-life extension resulting from MAP as well as for colour of ground beef stabilized by MAP/CO. In addition, we test the effect of different information types regarding MAP and MAP/CO on consumers' WTP as well as the effect of labeling the information on the packages.

We apply choice experiments as they deliver the most appropriate tool set to isolate individual product characteristics and their specific influence on price, and to provide insight into consumers' WTP. In choice experiments, respondents are asked to make repeated choices between different consumption bundles which include different attributes, and respective levels of these attributes. The respondents' utility depends on attribute levels of the choices made from these sets. This procedure enables the researcher to determine the attributes which influence the choice significantly and the marginal WTP for an increase/ decrease in the significant attributes (GOLDBERG AND ROOSEN, 2007).

3.1. Design of choice experiments

Following ALFNES ET AL. (2006) we run a choice experiment to collect data that provide stated preferences of Canadian consumers for pre-packaged ground beef (1 lb). Ground beef is a staple in the diet of industrialized countries (AMI, 2002). Our experimental design is as follows.

High quality photographs of ground beef packaged in white Styrofoam packages wrapped in transparent foil were taken. We set nine 'trays' on a table. Each of the 'trays' represented one scenario. On each 'tray' we displayed two photographs of consumer packages of ground beef (see figure 1).

Figure 1: Experimental set up

Participants made repeated choices between scenarios of two different ground beef packages. The two alternatives of ground beef on each tray were referred to as Alternative 1 and Alternative 2. The experimental design included three attributes, namely colour, shelf life and price with three levels each (see Table 1). The attributes differed from scenario to scenario according to a fractional factorial design.[1]

[1] To generate the fractional factorial design SAS was used.

Table 1: Attributes of the ground beef

Attribute	Price	Shelf life	Colour
Level	CAD-$ 2.58/lb	3 days	Light red
	CAD-$ 3.07/lb	5 days	Cherry red
	CAD-$ 3.57/lb	14 days	Brownish red

We had three consecutive treatments.[2] During the experiments participants received different information. Before treatment 1 participants had no information. Before treatment 2 we verbally provided information about shelf life, i.e. the role of MAP in extending the shelf life. Before treatment 3 we verbally provided information about the role of CO in stabilizing the colour. All information was technical information but presented in "lay" language and neutral without risk or benefit information included.

While we provided the full sample verbally with information on MAP and MAP/CO, a sub-sample (sub-sample 1) also had the products labelled (see Table 2). That is, the sample was split. One half made choices between ground beef packages carrying MAP labels, the other half made choices between ground beef packages not carrying any MAP labels. While sub-sample 1 was enabled to make an informed choice, sub-sample 2 received only verbally information on MAP and MAP/CO but did not know whether or not the specific ground beef packages were packaged under a modified atmosphere – a situation that reflects the current market situation. That is sub-sample 2 remained uncertain whether MAP or MAP/CO was used in any of the packages, but could possibly deduce it from the colour and shelf life combination.

Table 2: Information provided verbally (full sample) and labels used [sub-sample 1 only] in the treatments (T)

	Information provided [full sample]	Label [sub-sample 1 only]
T 1	None	None
T 2	Detailed/ neutral on MAP for extending shelf life	"modified atmosphere packaging" (on packages with 14 day shelf life)
T 3	Detailed/ neutral on MAP/CO for stabilizing colour	"modified atmosphere packaging with carbon monoxide" (on packages with cherry red ground beef)

Each participant made nine choices times the three different treatments. This means that each participant made 27 choices in total. To summarize, in each treatment nine 'trays', each with 2

[2] Note, there was a fourth treatment which will not be referred to in this paper regarding natural packaging methods such as rosemary extract.

photographs of packages of ground beef, were displayed. The ground beef was characterized by different combinations of the attributes colour, shelf life and price. For example a ground beef package might have a cherry red colour, a shelf life of 5 days and cost CAD-$ 3.07 in the first treatment. In the third treatment – for sub-sample 1 only – this ground beef would be labelled 'modified atmosphere packaging with carbon monoxide' because of the cherry red colour.

The photographs were taken of light red ground beef packaged at a university meat lab with pure air. The brownish red ground beef had been packaged at the meat lab with pure air but had been irradiated with 1 kG to achieve a standardized brownish red. The photographs of the cherry red ground beef were taken of ground beef packaged in MAP/CO, as can be purchased in a US American grocery store.

We ran the experiments with 20 groups (n=205). Participants received CAD-$ 20 each entering the experiment. They chose between the exact products they could obtain. After the last treatment of the experiment one of all choices was drawn randomly. To induce real economic incentives, each participant had to buy one of the packages, i.e. a randomly chosen product of the *m* products. In fact, for safety reasons after finishing the experiments, participants purchased a coupon for ground beef instead of actual product. This is a limitation regarding the set up of the choice experiments.

3.2. Sample structure

The study took place in 2008 in Alberta, Canada. The sample consisted of 205 randomly recruited participants. The sample is characterized by a higher share of female participants. As women are usually responsible for household grocery shopping this should not bias results in a negative way. The average age of participants is 48 years. The household size counts between two and three persons. The sample is characterized by a rather high education level. The income classes are almost equally distributed except for a lower share of the income class of less than CAD-$ 10,000 annual income and a higher share in the two highest categories. In this regard, it is useful to note that in Canada, and especially in the province of Alberta, a relatively high income is typical due to the 'oil boom'. See table 3 for the complete sample structure.

Table 3: Sample structure

Sample characteristics	Mean	Std.-Dev.	Min	Max
Gender (Female)	61%	0.5	0	1
Age in Years	47.7	15.5	18	89
Household Size	2.6	1.4	1	11
Children under 12	20%	0.4	0	1
High School EDU	12%	0.3	0	1
Some College	17%	0.4	0	1
Technical Degree	10%	0.3	0	1
Associate Degree	2%	0.2	0	1
BSc Degree	30%	0.5	0	1
MSc Degree	20%	0.4	0	1
PhD	8%	0.3	0	1
Y lower than 10,000 CAD $	5%	0.2	0	1
Y 10,000-29,999 CAD $	19%	0.4	0	1
Y 30,000-49,999 CAD $	16%	0.4	0	1
Y 50,000-69,999 CAD $	16%	0.4	0	1
Y 70,000-99,999 CAD $	21%	0.4	0	1
Y greater than 100,000 CAD $	23%	0.4	0	1

3.3. Mixed logit model

To analyze the data a multinomial mixed logit model with random and independent parameters to capture taste variations is used. Compared to the fixed coefficient multinomial logit and its extensions (e.g. nested logit), the mixed logit has the relevant advantage of allowing for taste heterogeneity unconditional on socio-economic covariates (MENAPACE ET AL., 2008). Moreover, the mixed logit obviates three limitations of the standard logit model by allowing for random taste variation, unrestricted substitution patterns, and correlation in unobserved factors over time (TRAIN, 2003). This is particularly relevant because several studies have shown that taste variation is only partially linked to and poorly explained by socio-economic variables such as age and income (e.g. BAKER AND BURNHAM, 2001).

The mixed logit can be defined as any model whose choice probabilities are integrals of standard logit probabilities over the density of parameters to be estimated. It can be specified via random parameters in the utility function and the goal is to estimate the *moments* of the distributions of individual-specific taste parameters.

The following example explains this point. One of the explanatory variables used in the model is the colour ‘cherry red’. It is reasonable to assume that consumers differ in their level of appreciation for a specific colour of ground beef. Some consumers may prefer cherry red while

others may prefer a lighter colour produced with pure air. In this model, the random behaviour of taste for the variable 'cherry red' is described by a normal distribution with a certain mean and variance. The mixed logit task is to estimate mean and variance, which completely describe the normal distribution.

An important implication of the mixed logit is that probability statements can be attached to the values of these parameters. The mixed logit produces efficient parameter estimation when the same individual makes repeated choices since it considers the correlation over sequential choices induced by the variability in the individual-specific parameters.

Model specification and estimation

Each decision maker i $(i = 1,...,205)$ faces $T = 9$ choice situations $(t = 1,...,T)$. In each choice situation, the decision maker is presented with a set of alternatives. Each set contains 3 elements: 2 ground beef alternatives and the 'no purchase' alternative. In total, there are $J = 19$ alternatives, indexed by $j, j = \{1,...,J\}$, including 18 ground beef packages and the 'no purchase' (j_{19}). J_t represents the set of alternatives at time t, for $t = 1,...,T$, $\mathrm{J}_t = \{j_{2t-1}, j_{2t}, j_{19}\}$.

The choice probabilities of a mixed logit for panel data and with linear random utility function can be specified as shown in the following. The utility of individual *i* from alternative *j*, in choice scenario t, is denoted by

$$U_{ijt} = \beta_i x_{ijt} + \varepsilon_{ijt}, \qquad (1)$$

where ε_{ijt} is distributed iid extreme values over individuals, alternatives and time, and x_{ijt} is a vector of observed variables relating to alternative j, which is described below in detail. β is a vector of unobserved coefficients that vary over individuals but not over alternatives (representing the individuals' tastes). It varies over individuals with density $g(\beta|\theta)$, where θ represents the parameters of this distribution. For example, if β is normally distributed in the population θ represents the mean and covariance (REVELT AND TRAIN, 1999).

Within a choice set, an individual chooses the option that maximizes utility within the given set. Let y_{it} denote the individual's chosen alternative in situation t, and let $y_i = y_{i1},..., y_{iT}$ denote the person *i*'s sequence of chosen alternatives. Since the ε_{ijt}'s are distributed extreme value, the probability conditional on β_i that the individual chooses alternative j in situation t is standard logit (MCFADDEN, 1973, IN REVELT AND TRAIN, 1999):

$$L_i(j,t|\beta) = \frac{e^{\beta_i X_{jt}}}{\sum_j e^{\beta_i X_{jt}}} \qquad (2)$$

and since the ε_{ijt}'s are independent over choice situations, the probability of the individual's sequence of choices, conditional on β_i, is the product of logits:

$$P(y_i|\beta_i) = L(y_{i1},1|\beta_1) \cdot \ldots \cdot L(y_{iT},T|\beta_i) \ . \qquad (3)$$

We do not observe β_i, and so these conditional probabilities are integrated over all possible values of β_i, using the population density of β_i,

$$P(y_i|\theta) = \int P(y_1|\beta_1) g(\beta_i|\theta) d\beta_i \ . \qquad (4)$$

$P(y_i|\theta)$, which is called the mixed logit choice probability, is the probability of the individual's sequences of choices conditional on the parameters of the population distribution, $g(\beta_i|\theta)$. The integral in the mixed logit probability generally does not have a closed form, and so it is approximated numerically through simulation. The parameter estimation is obtained by maximizing the simulated log-likelihood function. The estimated coefficients in the (linear) utility function vary over people but are constant over choice situations for each individual. Properties of the maximum simulated likelihood estimator are given by HAJIVASSILIOU AND RUUD (1994) and LEE (1992) (see REVELT AND TRAIN, 1999).

We estimate three models. The parameter distributions are assumed to be independent normal distributions. Across individuals the price coefficient is fixed. The advantage of having a fixed coefficient for price is that the WTP for each non-price attribute has the same distribution as the attribute's coefficient. As suggested by TRAIN (2000) the mixed logit estimates presented in this paper are obtained via simulated maximum likelihood using 125 Halton draws. We use Paul Ruud's routine for the optimization. In the models seven explanatory variables are included. Table 4 gives a summary of the included variables.

Table 4: Summary of variables used in the analysis

Variable	Variable definition
Price	Continuous variable indicating price of CAD-$ 2.58, CAD-$ 3.07 or CAD-$ 3.57
Shelf life of 3 days	Dummy variable equal to 1 if ground beef alternative has a 3 day shelf life.
Shelf life of 14 days	Dummy variable equal to 1 if ground beef alternative has a 14 day shelf life. 5 day shelf life was excluded because of multicollinearity.
Colour light	Dummy variable equal to 1 if ground beef alternative is Light red (aerobic)
Colour cherry	Dummy variable equal to 1 if ground beef alternative is Cherry red (MAP/CO). Brown was excluded because of multicollinearity.
NOT	Dummy variable equal to 1 if the *N*one-*O*f-*T*hese option was chosen for a choice set.
Label yes	Dummy variable equal to 1 if a label was present on the alternative (only sub-sample 1).

To estimate the model we use the mixed logit code for Gauss written by Train. The code is designed for panel data and accounts explicitly for the correlation over time in unobserved utility that arises when there are repeated choices by a given individual.[3] We use the panel version of the mixed logit code because each participant gives rise to a panel of nine choices. In the model six random coefficients and one fixed coefficient (price) are used. Please note, this model does not include any alternative specific constants (see e.g. Train, 2003, 24p.; Hensher et al., 2005, 312/ 695).

4. Results

We estimated three independent models. One for each of the three treatments where each of the 205 participants made nine choices. Thus, we have nine observations times 205 participants for each of the three models (one model for each of the three treatments). In the experiments participants had no information before treatment 1. They received information before treatment 2 and before treatment 3. Thus, we model the influence of information on their choices by running three single models. The results of the mixed logit estimates of our models for treatment 1 to treatment 3 are presented in Table 5. The price coefficient in all three rounds is expressed in CAD-$. WTP indicates the marginal WTP.

The estimated models show the following results and effects on consumers' WTP for ground beef:

[3] See http://elsa.berkeley.edu/~train/software.html, 2007.

Table 5: Parameter estimates

	Model Treatment 1 (n=205) [a]			Model Treatment 2 (n=205) [b]			Model Treatment 3 (n=205) [c]		
	Coeff. [1]	t-Value	WTP in CAD-$	Coeff. [1]	t-Value	WTP in CAD-$	Coeff. [1]	t-Value	WTP in CAD-$
Price (mean)	-1.231 ***	-19.315		-1.335 ***	-20.174		-1.241 ***	-18.507	
3 Day Shelf Life (mean)	-0.190	-1.617	-0.15	-0.188	-1.642	-0.14	-0.083	-0.851	-0.07
(std.-dev.)	0.426 *	2.112		0.497 ***	2.684		0.130	0.403	
14 Day Shelf Life (mean)	0.327 **	2.491	0.27	0.423 ***	3.487	0.32	0.373 ***	3.182	0.30
(std.-dev.)	1.003 ***	7.967		0.911 ***	7.371		0.907 ***	7.873	
Light Colour (mean)	0.589 ***	6.660	0.48	0.543 ***	5.265	0.41	0.508 ***	5.376	0.41
(std.-dev.)	0.352	1.746		0.804 ***	6.500		0.464 ***	-3.214	
Cherry Red Colour (mean)	1.449 ***	10.711	1.18	1.113 ***	8.309	0.83	1.041 ***	7.725	0.84
(std.-dev.)	1.548 ***	10.601		1.508 ***	11.112		1.553 ***	12.276	
NOT (mean)	6.410 ***	13.362	5.21	7.984 ***	11.979	5.98	7.285 ***	12.493	5.87
(std.-dev.)	3.128 ***	8.805		3.757 ***	8.853		3.434 ***	8.506	
Label Yes (mean)				-1.043 *	-2.158	-0.78	-1.250 *	-2.322	-1.01
(std.-dev.)				0.114	0.253		1.699 **	2.448	

[1] Significance level: ***p<0.01, * p<0.05, *p<0.1; std.-dev.=standard deviation

[a] LL value: -1410.14

[b] LL value: -1399.11

[c] LL value: -1442.66

Price had a negative effect on product choice in all three treatments. The higher the price, the less likely were participants to choose the product.

With regard to a 3 day shelf life there are no significant coefficients to state for the mean in all three rounds. Nevertheless, the coefficient for the standard deviation is significant in treatment 1 and treatment 2 and indicates significant heterogeneity among consumers. In contrast to that, results show a significantly positive effect for a 14 day shelf life compared to a 5 day shelf life indicating that consumers are willing to pay more for a longer shelf life. From the food industry's perspective this is a satisfying result as the industry introduced MAP to increase shelf life of ground beef in the first place. As mentioned in the introduction the increased shelf life has a clear benefit for producers and retailers. Moreover, this should be a benefit for consumers as well in terms of valued storage possibilities. The results even show that after introducing the information that MAP is the reason for the shelf life extension the WTP increases about 5 cents from treatment 1 to treatment 2. One reason may be that although consumers were suspicious of a shelf life of 14 days, the explanation of MAP causing the long shelf life was convincing and reassuring. However, the WTP drops slightly (about 2 cent from treatment 2 to treatment 3) after the consumer is introduced to MAP/CO. This result leads to the conclusion that provision of information on MAP and MAP/CO in packaging affects participants' choice of ground beef.

Consumers WTP for attractive colour of ground beef declines if MAP or MAP/CO are applied. Signalling the use of these technologies decreases consumers' WTP for colour. With regard to the heterogeneity, there are significant results for the std.-dev. Coefficients. This result leads to the conclusion that there is a fair share of consumers that differs from the mean WTP for a longer shelf life.

MAP/CO was introduced to stabilize the colour of ground beef. The results in the three treatments suggest that participants preferred cherry red meat resulting from MAP/CO over brownish red meat in all three treatments. The WTP for this colour was lower under treatments 2 and 3, compared with treatment 1. The participants' WTP for the cherry red colour decreased from CAD-$ 1.18 to 0.83 after they received information on the use of MAP. The light red ground beef had a significantly positive coefficient on product choice in treatments 1 to 3 as well, but the WTP for light red ground beef was lower than the WTP for cherry red.

With regard to the NOT variable, which refers to the fact that some participants decided to choose neither alternative, we find this factor has a significant and negative effect in treatment 1 but a significant and positive effect in treatments 2 and 3.

Regarding the effect of labeling information on the product, we find that labeling has a significant and negative effect in treatments 2 and 3. This leads to the conclusion that it is not the information alone but especially its labeling that decreases consumers' WTP and accordingly influences preferences. This was also shown in the past for irradiated products as well as products labelled as genetically modified. To date, there is no mandatory labeling in North America for MAP products. However, it is mandatory in Europe but under another name that might be translated as 'protected atmosphere' (Schutzatmosphäre). This leads to the conclusion that the mandatory labeling in the first place could lead to a reduced demand for MAP products. Moreover, the different labeling could also affect consumers' purchase behaviour. One might assume that consumers associate something positive with 'protected' but not necessarily with 'modified'. These facts have to be considered with future labeling and communication strategies as well.

5. Discussion and conclusion

This paper deals with consumers' purchase decisions for ground beef packaged under modified atmosphere with and without carbon monoxide. As so far no studies have analyzed consumers' response and economic valuation of this technology we applied choice experiments to uncover consumers' WTP for ground beef attributes related to the packaging technology. We examine response to shelf life which is extended by MAP and colour which is stabilized by MAP/CO. The choice experiments contained three treatments providing consumers with alternative types of information. Results from mixed logit models reveal that there is no significant WTP for 3 day shelf life but there is for 14 day shelf life. Findings for the different colours – light (from a pure air packaging) and cherry red (from MAP/CO packaging) compared to the brownish red ground beef – show a significant preference by consumers for ground beef with a brighter red. But, there is quite a bit of variation in WTP for the colours light and cherry red across treatments 1 to 3. After introducing MAP to participants, their WTP for light red ground beef decreases about 7 cents and their WTP for cherry red ground beef decreases about 35 cents. However, after the additional introduction of carbon monoxide as colour stabilizer in treatment 3 the WTP for lighter as well as cherry red colour remains stable. This may be due to providing an explanation for the reasons behind the colours. It is possible that consumers hold more trust in a technology once it is explained to them. Nevertheless, a label on the product leads to a decreasing WTP.

To conlcude:

- Shelf life extension affects consumers' WTP for ground beef. A 14 day shelf life increases the WTP about CAD-$ 0.30.
- Consumers have clear preferences for light and cherry red colours. This result emphasizes the importance of colour stabilization. Without having any technological knowledge, consumers are willing to pay about CAD-$ 1 more for cherry red ground beef.
- Labeling has a negative effect on WTP for new technologies. Those who had products labelled in treatment 2 show a WTP that is lower by about CAD-$ 0.80; in treatment 3 the WTP is even lower, by about CAD-$ 1.00.

Consumers' WTP for new technologies in fresh meat products has important implications for public health policy, marketing as well as research and development. Perceived benefits of red colour and higher WTP for products may dissipate when consumers are informed about the packaging technologies used and products are carrying labels. Regarding the meat industry, our results indicate the importance for industry to developing a clear communication to improve consumers' education and change (improve) consumers' attitudes regarding MAP. Such communication might highlight the advantages of MAP such as shelf life extension and increasing food safety for consumers, at the same time as providing information on the technology.

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