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Zero-inflated ordered probit approach to modeling mushroom consumption in the United States

RESEARCH ARTICLE

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Abstract

This paper investigates the determinants of fresh and processed mushroom consumption in the United States by employing the zero-inflated ordered probit (ZIOP) model. The ZIOP model accounts for excessive zero observations and allows us to differentiate between genuine non-consumers and individuals who did not consume during the given period but might under different circumstances. The results indicate that the market for fresh mushrooms is larger than that for processed mushrooms. However, the market for processed mushrooms has a larger portion of potential consumers which might indicate more potential if appropriate marketing strategies are applied. The results also suggest that the decisions to participate in the market or not and the consumption frequency are driven by structurally different factors. A comparison of the ZIOP to other models is included to show the advantages of allowing for non-consumers and potential consumers to be analyzed separately.

Keywords: fresh and processed mushrooms, zero-inflated ordered probit model, consumption behaviors, double hurdle model
JEL code: D12, C35, C25

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1. Introduction

The United States is the world's second-largest producer of mushrooms, following China, with 16% of world output. Regarding the value of production, mushrooms are a leading U.S specialty crop, exceeded only by potatoes, tomatoes and lettuce. Consumption of mushrooms has been on the rise in the United States over the past several decades. Per capita consumption has quadrupled since 1965 (the first year for which reliable data are available). According to data compiled by the U.S. Department of Agriculture's (USDA) Economic Research Service (ERS), per capita use of all mushrooms totaled about 4.02 pounds in 2015, compared with 0.69 pounds in 1965 (Figure 1).

The mushroom market can be divided into two main categories: fresh and processed. Fresh mushrooms accounted for three-fourths of domestic consumption in 2015. Since 1990, per capita consumption of fresh mushrooms increased dramatically, while per capita consumption of processed mushrooms (mostly canned mushrooms) gradually declined. This deviation in the consumption trend happens for other fresh and processed fruits and vegetables as well. According to the USDA ERS 'disappearance data', annual per capita consumption of fruits and vegetables in both fresh and processed form has increased approximately 7.3% from 1979 to 2015, reaching 678 pounds. Over this time, the consumption of fresh fruits and vegetables has been increasing significantly faster than the consumption of processed fruits and vegetables. Between 1976 and 2015, fresh vegetable consumption went from being the smaller part of vegetable consumption (45%) to the majority of consumption (54%). Although there is a similar trend in fruit consumption, processed consumption still dominates the market. From 1979 to 2015, the market share of fresh fruit has increased from 36 to 45%.

Most previous studies about mushrooms have focused on their nutritional and medical benefits. For example, Alam *et al.* (2008) and Chang and Buswell (1996) have shown that dietary mushrooms provide a wide variety of medicinal properties including anticancer, antibiotic, antiviral activities, immunity and blood lipid lowering effects. Anno *et al.* (2016) and Finimundy *et al.* (2014) reviewed the nutritional value of mushrooms and indicated that mushrooms were rich in protein with an important content of essential amino acids and fiber.

Aside from USDA disappearance data and retail sales information, few studies explore factors influencing mushroom consumption at the individual level. One exception is a study by Lucier *et al.* (2003). It indicates that compared to other consumers, Asian and non-Hispanic white consumers were the strongest consumers of mushrooms and per capita mushroom consumption was positively correlated with income. The study also found that men and women between 20 and 39 years old were the leading mushroom consumers, representing about 32% of the population, yet consuming 43% of all mushrooms.

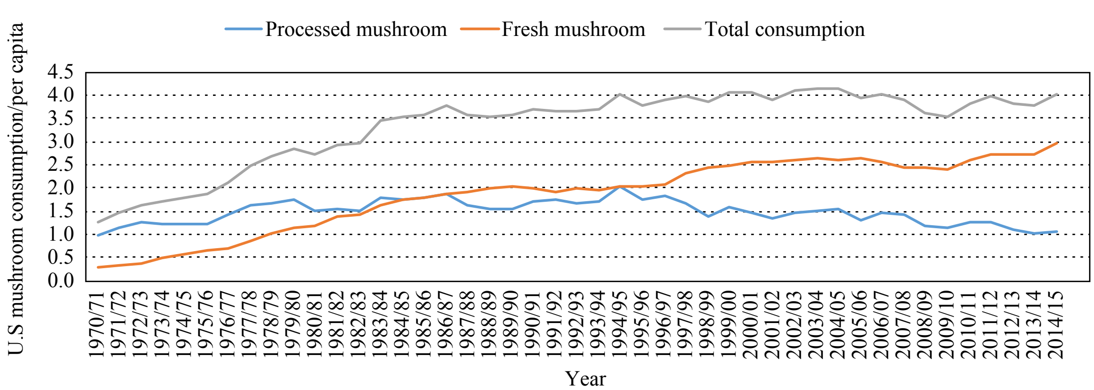

Figure 1. Mushroom consumption changes (data provided by U.S. Department of Agriculture's Economic Research Service).

To help fill this gap and investigate the growing market for mushrooms, the purpose of this study is to investigate and compare the determinants of fresh and processed mushroom consumption. Additionally, we will examine prior models used to understand food demand based on survey data.

When examining consumption of mushrooms, we can observe two main decisions: consumption (or non-consumption) and consumption frequency. Although there are two main decisions, we can identify three categories of consumers: those that 'never' consume (non-consumers); those that indicate that they did not consume in the specific period (potential consumers); and those that consumed mushrooms in the specific time period (consumers). A challenge with the data is both non-consumers and potential consumers are typically represented by 'zero' consumption, hence creating a situation where two types of zeros may be driven by different behaviors (Harris and Zhao, 2007). As a result, in this paper, unlike other literature in the food consumption, we will use the zero-inflated ordered probit (ZIOP) model to examine fresh and processed mushroom consumption to allow the investigation of non-consumers, potential consumers, and consumers. To the best of our knowledge, it is the first time that the ZIOP model was employed to analyze food consumer's behavior.

2. Literature review

Although little research has been published concerning consumer behavior in the mushroom market, much empirical research has been conducted on general fruit and vegetable consumption, and on specific products (i.e. blueberries (Shi *et al.*, 2011), lettuce (Hospido *et al.,* 2009), fresh citrus (Gao *et al*., 2011), and tomato (Lucier *et al.*, 2000)). In this section, we identify the factors that may influence consumer behavior in the mushroom market based on reviewing previous studies on fruit and vegetable consumptions.

Previous research has shown a relationship between demographic factors and fruit and vegetable consumption. For example, studies found that there were large variations in fruit and vegetable consumption among regions, age groups, gender, and social classes. Consumers who have higher education, income, and social status would be more likely to have a higher consumption of fruits and vegetables (i.e. Ball *et al.*, 2015; Konttinen *et al.*, 2013). It indicates that education, ethnicity and household size also have been correlated with the frequency of vegetable consumption (Cook, 2011; McMahon *et al.*, 2013).

Culture, tradition, and familiarity are also found to play an important role in influencing consumption of fruits and vegetables. Culture and tradition were considered as the foundations on which all food choice decisions are built, and have a significant correlation with fruit and vegetable consumption (Pollard *et al.,* 2002). Schroeter and House (2015) found that the impact of culture on food choice is large and varied. They found that family consumption of fruits was highly predictive of the individual's consumption of fruits. McMahon *et al.* (2013) illustrated that familiarity links closely with consumers' selections of vegetables and consumers are more likely to have a strong preference for familiar vegetables when they made food choices.

In addition to effects of culture and food habits, a growing number of studies indicated that information about health and nutrition is important factors influencing fruit and vegetable consumption. Rekhy and McConchie (2014) and Cook (2011) found that a belief in the health benefits of fruit and vegetables would increase consumption, and consumers' concerns about nutrition were positively related to the consumption behavior.

Cost is another factor affecting the consumption of fruits and vegetables. Many studies found that price was one of the most influential factors on food choice, especially for those in lower socioeconomic groups, for example, students, the retired and the unemployed (Waterlander *et al.,* 2013). Other studies suggest that price was one of the barriers to eating more fruits and vegetables for low-income families in the United States (Cassady *et al.,* 2007).

Other factors that have been identified as barriers to vegetable consumption include preparation time (Rekhy and McConchie, 2014), convenience (McMahon *et al.*, 2013; Nijmeijer *et al.*, 2004), sensory factors (taste preferences) and ‘freshness’ (Cook, 2011; Coulthard and Blissett, 2009; Kaminski *et al.*, 2000; Lucan *et al.*, 2010).

3. Data

An online consumer survey was designed to investigate consumption and knowledge of fresh and processed mushrooms. In September 2012, a random sample of 1,217 respondents in the United States was recruited through a national survey panel. The target sample included adults, aged 18 or older, living in the United States. A total of 1,217 respondents initiated the survey, and 674 respondents completed the survey, for a response rate of 55.4%. In order to eliminate redundancy and any perceived bias, the draft survey questionnaire was pretested by employing the cognitive interviewing. Pretesters were asked to provide feedback concerning the survey length, survey content, and question clarity, and the survey was revised based on their comments. Furthermore, to better assess the survey design and respondent characteristics, before the full launch of the survey, we performed a ‘soft launch’, in which 75 complete responses were collected and analyzed. The survey included three parts: attitudes and perceptions about health benefits of food in general, then mushrooms specifically; consumption habits related to fresh and processed mushrooms; and demographics.

Due to the difficulty in collecting the price information across different purchase locations, purchase frequency information is used to represent the consumption amount for each household. In the survey, we first asked whether the respondent had ever purchased fresh or processed mushrooms, and for those that replied positively, whether they had purchased fresh or processed mushrooms in the past month. For those respondents who had purchased in the prior month, a second follow-up question asked how often they purchased during that period. One month was used to help with the accuracy of the data as it is difficult for people to recall purchases more than one month ago.

The key dependent variables in this paper are two ordered variables: Fresh_Freq, and Prossed_Freq for the consumption of fresh mushrooms and processed mushrooms, respectively (Table 1). As described above, the variables of consumers’ consumption frequency are collected through the two questions in succession. At first, it was asked ‘Have you purchased fresh/processed mushrooms before?’, where a binary ‘Yes/No’ answer is required. Secondly, for those answered ‘Yes’ to the first question, another question how frequently mushrooms had been purchased in the past month with the answer options being ‘none/only 1 time/more than 1 time.’ Both the respondents who answered ‘No’ to the first question, and the respondents who answered ‘None’ to the second question would typically be treated as zero in the ordered variable of consumption, but the zeroes represent two decisions: whether to participate in the market and whether to purchase in the prior month. Thus the variable of Fresh_Freq/Prossed_Freq are three-level ordered variables, taking the form of the following choices: never participate or did not consume in the last month (y=0); consume one time in the last month (y=1); consume more than 1 times last month (y=2).

The independent variables used in the analysis are shown in Table 1, along with their mean values and descriptions. Based on the literature review, the variables consist of three sets. The first set of variables includes sociodemographic characteristics: age of the respondents, gender, education level, race, household income, and weekly food budget, and vegetarian (or not). The second set of variables focuses on consumers’ health and nutrition knowledge regarding general food and then mushroom specifically. The last set of variables is a ranking of how important attributes of mushrooms, including price, taste, convenience, diversity, and safety are to consumers when making purchase decisions.

Table 1. Variable descriptions.

Variables	**Description**		**Value (%)**
Fresh_Freq	Consumption frequency of fresh mushrooms in the last month	Never/none	37.2
		1 time	38.9
		More than 1 time	23.9
Processed_Freq	Consumption frequency of processed mushrooms in the last month	Never/none	55.7
		1 time	29.1
		More than 1 time	15.2
Male	% of sample male		45.1
College	% of sample with more than high school education		77.0
Age	Age in years (continuous in analysis)	18-29 years	22.5
		30-39 years	18.9
		40-49 years	21.4
		40-69 years	31.2
		70+ years	5.3
Income	Estimated household income	$24,999 or less	27.0
		$25,000-$34,999	10.7
		$35,000-$49,999	15.3
		$50,000-$74,999	21.5
		$75,000-$99,999	10.6
		$100,000+	14.9
Hispanic	% Hispanic		7.4
Black	% black/African American		11.1
Asian	% Asian		7.7
White	% white		75.5
Otherrace	% other races		2.7
Knowledge_Immunity	% who believe mushrooms boost immunity		11.0
Preventative	% who believe food helps relieve symptoms of illness		18.6
Health_Aware	% who are aware of specific health benefits of mushrooms		18.5
Budget	Food budget per week	Less than $49	12.2
		$50-99	36.3
		$100-149	32.7
		$150-199	10.8
		$200-$249	3.5
		$250+	4.5
Vegetarian	% vegetarian		6.5
Taste	% who indicate taste as a reason for eating/not eating mushrooms		82.7
Price	% who indicate price as a reason for eating/not eating mushrooms		44.1
Convenience	% who indicate convenience as a reason for eating/not eating mushrooms		59.7
Mushroom_health/safety	% who indicate health as a reason for eating/not eating mushrooms		39.7
Diversity	% who indicate diversity as a reason for eating/not eating mushrooms		48.6

4. Method

When using survey data to gather information on consumption behavior, two pieces of information are usually gathered: consumption (or not) and consumption frequency. However, there exists three types of consumers: non-consumers (those never consume), potential consumers (those who did not consume in the specific period, but who do consume at other points in time), and consumers (those who consume in the specific period). Although both the non-consumers and potential consumers report zero consumption, they are driven by different factors. Non-consumers may choose not to consume mushrooms because of some stable reason, like eating habits, taste preferences, or allergies and they may be less likely to change their eating habits regarding mushrooms easily. At the same time, zero consumption might also be reported for potential mushroom consumers who did not consume during the prior month (or a specific time period studied). The potential mushroom consumer made their decision of 'non-consumption' as a corner solution to the standard demand problem. It can be expected that the underlying process driving the behaviors of these two types of zero-consumption consumers can be different. If we use a simple discrete choice model (i.e. an ordered probit/logit model) the two types of zeroes will not be differentiated, and the model may fail to capture the true reasons behind the zero observations.

In previous research, logistic regression models were widely used to examine factors influencing fruit/vegetable consumption frequency (i.e. Casagrande *et al.*, 2007; Dehghan *et al.*, 2011; Riediger *et al.*, 2007). As developed, the logistic regression model has been combined with Heckman selection models in which the consumption frequency was considered as conditional on those choosing to participate, thus allowing factors influencing consumption frequency to be different from the factors influencing participation (Chern *et al.*, 2003; Nayga, 1995). Double-hurdle models have also been employed to analyze the fruit and vegetable consumption (Reynolds, 1990; Shi *et al.*, 2011).

Another approach to modeling the data is suggested by Harris and Zhao (2007), who proposed the ZIOP. The ZIOP model consists of a split probit model and an ordered probit model with potentially different sets of covariates. The system of the probit model and the ordered probit is generated by two latent equations which allow for the differentiation between the two separate processes generating zero observations. Furthermore, the error terms of these two latent equations are allowed to be correlated. Although the use of ZIOP model is not entirely new to economic analysis[1], to the best of our knowledge, this is the first time it is employed to analyze food consumer's behavior.

We define X reflecting individuals' characteristics including demographics, food habits (vegan or not), health and nutrition knowledge about mushrooms, and Z reflects the ratings of the importance mushrooms characteristics including taste, price, convenience, availability and diversity added to the daily diet. Since non-consumers of mushrooms have not purchased mushrooms, we only include their individual characteristics in the participation stage, yet for consumption stage, we include both individual's characteristics and mushroom characteristics. In the following model, we let the matrix W include both X and Z.

The ZIOP model involves two latent equations: a probit selection equation and an ordered probit equation. The probit selection equation can be expressed as:

$$R_i^* = X_i'\alpha + u_i;\ R_i = \begin{cases} 1\ if\ X_i{}'\alpha + u_\mathrm{i} > 0 \\ 0\quad otherwise \end{cases} \tag{1}$$

Equation 1 works to analyze the binary decision to participate in the mushroom market or not. Where R_i is a dichotomous variable indicating whether or not consumers decided to participate, and R_i^* is the latent variable measuring consumers' propensity for participation to purchase mushrooms. X is the vector of explanatory variables; u is the error term.

Conditioning on participation (R=1), consumers need to further decide on how much to consume. The consumption frequency can be represented by a discrete variable D_i which is generated by an ordered probit model through the second latent variable D_i^*. The ordered probit equation is expressed as Equation 2.

$$D_i^* = W_i{}'\beta + \varepsilon_i, \text{if } R_i{=}1;\ D_i = \begin{cases} 0\ if\ D_i^* \leq 0 \\ \mathrm{j}\ if\ \gamma_{j-1} < D_i^* \leq \gamma_j\ \ (\mathrm{j} = 1, \ldots \mathrm{J} - 1) \\ \mathrm{J}\ \ \gamma_{J-1} < D_i^* \end{cases} \tag{2}$$

[1] Downward *et al.* (2011) used the ZIOP model to analyze sports participation. A second study employed the ZIOP model was to analyze two types of peace in social science (Bagozzi *et al.,* 2004).

where W is the set of explanatory variables, including both X and Z, ε is the error term for the ordered probit equation, and γ is the cutoff parameters. We include three consumption levels in the survey (0=no purchase in the past month, 1=purchased one time, and 2=purchased more than 1 time per month). Because the model assumes γ_0=0, we will estimate another cutoff from the model.

The error terms of Equation 1 and 2 are allowed to be correlated, and the joint distribution function of (u_i,ε_i) is assumed to be Gaussian, with zero means, unit variances, and correlation coefficient defined as ρ.

Since in the ZIOP model, the decision on whether or not to participate and how much to consume are not separately determined, the indicators D and R are not individually observed. To observe the consumption frequency Y, it was given the following criteria: Y=R*D. According to this criteria, a positive Y was observed when R=1 and D>0; Y was observed as zero when R=0 or D=0. Thus, with this model specification, the probability of non-participation is:

$$\Pr(R_i = 0) = 1 - \Phi(X_i{'}\alpha) \tag{3}$$

The full probabilities for observing different levels of Y are given by:

$$\Pr(Y_i = \mathrm{j}) = \begin{cases} \Pr(Y_i = 0) = \Pr(R_i = 0) + \Pr(R_i = 1, D_i = 0) \\ \Pr(Y_i = \mathrm{j}) = \Pr(\,R = 1\,\&\,D = j)\ (j = 1, \dots J-1) \\ \Pr(Y_i = \mathrm{J}) = \Pr(\,R = 1\,\&\,D = J) \end{cases}$$
$$= \begin{cases} \Pr(Y_i = 0) = [1 - \Phi(X_i'\alpha)] + \Phi_2(X_i'\alpha, -W_i'\beta;\, -\rho) \\ \Pr(Y_i = \mathrm{j}) = \Phi_2\big(X_i'\alpha,\ \gamma_j - W_i'\beta;\, -\rho\big) - \Phi_2\big(X_i'\alpha,\ \gamma_{j-1} - W_i'\beta;\, -\rho\big) \\ \qquad\qquad (j = 1, \dots J-1) \\ \Pr(Y_i = \mathrm{J}) = \Phi_2\big(X_i'\alpha, W_i'\beta - \gamma_{J-1};\, -\rho\big) \end{cases} \tag{4}$$

From Equation 4, we could indicate that the probability of observing zero level consumption includes two separate processes: the probability of non-participation (R=0) and the joint probability of the choice to participate, but choose to purchase zero. It also indicates the probability of observing a positive consumption level is the joint probability of the choice to participate and to consume at the j-level intensity.

For almost all discrete choice models, marginal effects are useful to indicate the effectiveness of covariates on probability changes. For the ZIOP model, there are different sets of marginal effects which would be of interest to analyze. At first, it would be interesting to analyze the effectiveness of variables on the probability of 'participation'. Then, it will be very interesting to calculate the marginal effects in the ordered model, and compare the effectiveness of the independent variables on the probability of different levels of consumption intensity conditional on participation. What's more, based on the construct of ZIOP model, we can also observe the marginal effects of sets of explanatory variables on the overall probability for different levels of observed consumption. We calculate the marginal effects using the formulas shown in Harris and Zhao (2007: 1078).

The standard errors of the marginal effects in this study can be calculated using the Delta method (Greene, 2003) or the simulated asymptotic sampling techniques. Like Harris and Zhao (2007), considering the complexity of the marginal effects, the sampling technique is used in this case. To be more specific, we randomly draw θ (where θ is the parameters in the ZIOP model) from multivariate normal distribution ($\hat{\theta}$, $\widehat{\mathrm{var}}[\theta]$) 10,000 times, and for each draw, we calculate the marginal effects, and then calculate the standard errors. These empirical standard deviations of the simulated marginal effect are the valid asymptotic estimates of the true marginal effects' standard errors.

Furthermore, from the ZIOP model, we also calculate the expected probability of observing different levels of consumption: the probability of observing a non-consumer is expressed in Equation 5; the probability of observing a potential consumer (zero-consumption given participate) is expressed in Equation 6; and the probability of observing zero level of consumption is expressed in Equation 7; besides that, the probability of observing different levels of consumption given R=1 is given in Equation 8, and the probability of observing different levels of positive consumption is given in Equation 9.

$$E(R_i{=}0) = \Pr(R_i{=}0|X) = 1 - \Phi(X_i'\alpha) \quad (5)$$

$$E(D_i{=}0,\ R_i{=}1) = \Pr(R_i{=}1,\ D_i{=}0|X,W) = \Phi_2(X_i'\alpha, -W_i'\beta;\ -\rho) \quad (6)$$

$$E(Y_i{=}0) = E(R_i{=}0) + E(D_i{=}0,\ R_i{=}1) = 1 - \Phi(X_i'\alpha) + \Phi_2(X_i'\alpha, -W_i'\beta;\ -\rho) \quad (7)$$

$$E(D_i{=}j|R_i{=}1) = \frac{\Pr(D_i{=}d, R_i{=}1|X,W)}{\Pr(R_i{=}1|X)} = \frac{\Phi_2(X_i'\alpha, \gamma_j - W_i'\beta;\ -\rho) - \Phi_2(X_i'\alpha, \gamma_{j-1} - W_i'\beta;\ -\rho)}{\Phi(X_i'\alpha)} \quad (8)$$

$$E(Y_i{=}j) = \Pr(R_i = 1, D_i = j|X,W) = \Phi_2(X_i'\alpha,\ \gamma_j - W_i'\beta;\ -\rho) - \Phi_2(X_i'\alpha,\ \gamma_{j-1} - W_i'\beta;\ -\rho) \quad (9)$$

5. Results

Results indicate that 37.2 and 55.7% of participants did not purchase fresh or processed mushrooms in the past month, respectively. Of those that had not purchased, 54.5 and 56.2% reported that they have never purchased fresh or processed mushrooms, respectively (Figure 2). Of the total respondents, approximately 18.5% indicated they were aware of health benefits of mushrooms, and approximately 21.6% reported that they believed that mushrooms would help with immunity.

The estimated probabilities of different types of consumers for fresh and processed mushrooms from the ZIOP model are displayed in Table 2. Overall, the predicted probability of non-consumers of fresh mushroom is 18.0% (compared to the observed percentage of 20.3%), and the estimated predicted probability of potential consumers is 19.5% (compared to the observed percentage of 16.9%). For processed mushrooms, the estimated probability of non-consumers is 32.8% (compared to the observed percentage of 31.3%), and potential consumers is 24.0% (compared to the observed percentage of 24.4%). It indicates that the percentage of non-consumers of processed mushrooms is much higher than the percentage of non-consumers of fresh

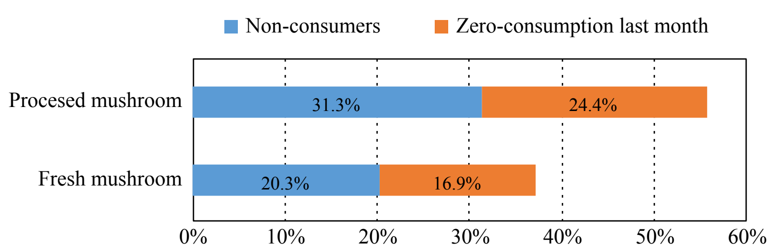

Figure 2. Zero consumption for fresh and processed mushrooms.

Table 2. Estimated probabilities for fresh and processed mushroom consumption.

	Binary probit			**Ordered probit**			**ZIOP[1] model**	
	Fresh	**Processed**		**Fresh**	**Processed**		**Fresh**	**Processed**
Pr(Y=0)	0.35	0.57	Pr(Y=0)	0.36	0.60	Pr(R=0)	0.18	0.33
						Pr(R=1, D=0)	0.20	0.24
Pr(Y>0)	0.65	0.43	Pr(Y=1)	0.50	0.30	Pr(R=1, D=1)	0.39	0.40
			Pr(Y=2)	0.14	0.10	Pr(R=1, D=2)	0.23	0.03

[1] ZIOP = zero-inflated ordered probit.

mushrooms (18%), yet the predicted percentage of potential consumers of processed mushrooms is higher than that for fresh mushrooms (19.5%). Thus, we could see that the fresh mushroom is more popular now, yet the market of processed mushroom has strong potential with a larger portion of potential consumers.

The OP model is conditional on Z, which treats all the observed zeros indifferently, and ZIOP model is conditional on both X and Z which allows zero observations to come from two different generating processes. Results for the likelihood ratio statistics for both fresh mushroom consumption and processed mushrooms consumption clearly reject the OP model. As for the information criteria, we can see that for processed mushroom consumption, the AIC clearly suggests the superiority of the ZIOP model over the OP model. For fresh mushroom consumption, the AIC suggests that the OP model is performing slightly better than the ZIOP model, although the difference is slight (Table 3).

5.1 Fresh mushroom consumption

Marginal effects on Pr(y=0) using a ZIOP model, compared with the results from the probit and ordered probit models are shown in Table 4[2]. For the ZIOP model, the overall marginal effect on Pr(y=0) was divided into two parts: the effect on non-participation (Pr(r=0)), and the effect on the participation with zero consumption Pr (r=1, d=0). In Table 6, we present marginal effects on the unconditional probabilities of positive levels of consumption (y=1, 2), using an ordered probit model versus the ZIOP model.

Focusing on the demographic characteristics, age is significantly negative in the ordered probit (OP), however, when looking at the results from the ZIOP model, age is significantly negatively correlated with participation, but is not related to consumption frequency, indicating that younger people are more likely to consume fresh mushrooms, but not consume them more frequently. Males were more likely than females to purchase mushrooms according to the binary probit model, but no relationship was found in the OP or ZIOP models. The variables representing race and ethnicity also have different results depending on which model is used. In the binary probit model, results indicate that African Americans are less likely than Whites to purchase mushrooms and the ordered probit model suggests Asian, Hispanics, and people of other races are more likely to consume fresh mushrooms. In the ZIOP model, the same results are found for consumption frequency as found in the OP model, but not participation (in this case, no race or ethnicity variables significantly influenced participation). Income is positive and significant in the binary probit model and the participation stage of ZIOP model, which indicates that people with higher income are more willing to consume fresh mushrooms, but higher income don’t translate to more frequent consumption. Weekly food budget is significantly positive in the probit model and the OP model. In the ZIOP model, we find that budget is significantly correlated with higher fresh mushroom consumption frequency, but it does not significantly influence consumers’ participation decisions. Thus, comparing the variable income and budget in the ZIOP model, we see that people with higher household income are more likely to try fresh mushrooms, and people with a higher weekly food budget are more likely to buy fresh mushrooms more

[2] As marginal effects are more easily interpreted, regression results are not displayed in the text, however they are discussed and provided in Supplementary Tables S1 and S2.

Table 3. Mushroom consumption: summary statistics from ordered probit and ZIOP models[1,2].

	Fresh mushroom consumption		**Processed mushroom consumption**	
	OP	**ZIOP**	**OP**	**ZIOP**
Log likelihood	-525.3	-513.2	-542.6	-524.4
AIC	1,086.6	1,088.4	1,121.2	1,110.8
LR versus OP	24.2* (df=13)		36.4** (df=13)	

[1] ** and * indicate statistical significance at 5 and 10% levels, respectively.

[2] ZIOP = zero-inflated ordered probit; AIC = Akaike information criterion; LR = Likelihood-ratio test; df = degrees of freedom.

Table 4. Fresh mushroom consumption: marginal effect for non-participation and zero.[1]

	Binary probit	**Ordered probit**	**ZIOP[2] model**		
			Non-participation	**Zero consumption given participation**	**Full zero consumption**
	Pr(y=0)	**Pr(y=0)**	**Pr(r=0)**	**Pr(r=1, d=0)**	**Pr(y=0)**
Male	-0.087**	-0.027	-0.061	0.021	-0.040
	(0.041)	(0.037)	(0.044)	(0.024)	(0.031)
College	-0.043	0.017	0.014	0.002	0.016
	(0.049)	(0.046)	(0.052)	(0.030)	(0.037)
Age	-0.002	0.036**	0.029**	-0.001	0.028***
	(0.013)	(0.012)	(0.014)	(0.009)	(0.010)
Income	-0.023**	-0.014	-0.022*	0.008	-0.015**
	(0.011)	(0.010)	(0.012)	(0.007)	(0.008)
Hispanic	-0.020	-0.221***	-0.175	-0.027	-0.20
	(0.096)	(0.064)	(0.198)	(0.076)	(0.142)
Black	0.121*	0.023	0.041	-0.015	0.025
	(0.069)	(0.067)	(0.076)	(0.043)	(0.053)
Asian	-0.216***	-0.130**	-0.071*	-0.028	-0.099*
	(0.063)	(0.059)	(0.042)	(0.047)	(0.065)
Otherrace	-0.176*	-0.197	0.010	-0.111	-0.100
	(0.094)	(0.076)	(0.104)	(0.071)	(0.082)
Budget	-0.053***	-0.058***	-0.019	-0.016*	-0.036***
	(0.019)	(0.017)	(0.022)	(0.010)	(0.015)
Vegan	0.031	0.004	-0.092	0.042	-0.050
	(0.088)	(0.078)	(0.112)	(0.049)	(0.080)
Knowledge_Immunity	-0.021	0.068	0.081	-0.022	0.059
	(0.066)	(0.061)	(0.117)	(0.065)	(0.068)
Preventative	-0.182***	-0.112**	-0.092**	0.007	-0.085***
	(0.047)	(0.046)	(0.050)	(0.031)	(0.038)
Health_Aware	-0.202***	-0.108**	-0.132***	0.012	-0.120***
	(0.046)	(0.047)	(0.064)	(0.034)	(0.046)
Taste	–	-0.076***	–	-0.028***	-0.028***
		(0.016)		(0.009)	(0.009)
Price	–	-0.017	–	-0.000	-0.000
		(0.018)		(0.008)	(0.008)
Covenience	–	-0.024	–	-0.018**	-0.018**
		(0.020)		(0.009)	(0.009)
Mushroom_health	–	-0.046**	–	-0.018***	-0.018***
		(0.015)		(0.007)	(0.007)
Diversity	–	-0.008	–	-0.005	-0.005
		(0.018)		(0.008)	(0.008)

[1] Standard errors are in parentheses; ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively.

[2] ZIOP = zero-inflated ordered probit.

often. The variables for education was not related to mushroom consumption or frequency of consumption in any model. Considering consumers' food habits, vegetarian was not found to be significantly correlated with either participation or consumption of mushroom.

The estimated results indicated that consumers who were aware of the health benefits of mushrooms are significantly more likely to consume fresh mushrooms in the binary probit and ordered probit models. However, when looking at the results from the ZIOP model, we found that consumers' awareness of health benefits only significantly influences the decision of participation, not consumption frequency. Similar results are found for consumers' belief in certain foods ability to aid in recovery from illness. The coefficient of this variable is statistically significant in all three models, however, with the ZIOP model, it is only significant in the first stage (decision to participate). The belief that mushrooms boost immunity was not significant in any model.

When looking at the mushroom characteristics in the ZIOP model, we find that taste, convenience and health benefits of mushrooms are the three significant factors which are positively correlated with fresh mushroom consumption frequency, while the price and diversity added to daily diet are not statistically significant in the case of fresh mushroom consumption.

The marginal effects (shown in Tables 4 and 5) highlight some interesting results. As previously mentioned, one of the advantages of the ZIOP model is its capability to disentangle the total effect of a covariate on Pr(y=0) into those effects on the probabilities of the two types of zeros: Pr(r=0) and Pr(r=1, D=0). One example in the case of fresh mushroom consumption is the age effect. From the OP model, one would conclude that older people are more likely to be non-consumers (by 0.036, Table 4). When examining the age effect in the ZIOP model, we see that the dominant effect of age is on the probability to be a non-participant (by 0.029), yet it does not exert any influence on the probability to be a potential consumer. Thus, we conclude older people are more likely to be a non-participant for fresh mushroom consumption, but no more likely than other ages to be a potential consumer.

Another example is consumers' awareness of health benefits. In the OP model, when consumers were aware of the benefit of eating mushrooms, the probability of being non-consumer was lower (by -0.108, Table 4). However, when dividing the effect of health benefits into two categories, we could see that consumers' awareness of health benefits only significantly correlated with consumers' participation decision (by -0.132, Table 4), but did not significantly effect consumption frequency. Thus, we could conclude that people being aware of mushroom benefits would be more likely to try fresh mushrooms, yet it will not influence consumers' decisions on how much to consume.

Regarding the potential unobserved effect, the ZIOP model for fresh mushroom suggests that there is no significant correlation existing between the participation decision and consumption decision. This indicates that for the promotion of fresh mushrooms, marketing strategies to attract new consumers should be different than those targeting increased consumption frequency for existing consumers, and vice versa.

5.2 Processed mushroom consumption

Marginal effect results for processed mushroom consumption are shown in Tables 6 and 7[3]. Focusing on the demographic variables, gender and education were not significantly related to processed mushroom consumption for any model. Age is only significant in the binary probit model, but not significant in either stage of the ZIOP model. Income is significant in the ZIOP model, where it is negatively related to the consumption participation decision, yet positively related to consumption frequency. Weekly food budget is significantly positive in the probit model, OP model, and the participation-stage of ZIOP model, but is not correlated with consumers' consumption frequency. This suggests that people with a higher food budget will be more willing to consume processed mushrooms.

[3] Regression results for processed mushrooms are displayed in Supplementary Tables S1 and S2.

Table 5. Fresh mushroom consumption: marginal effect for non-zero consumption levels.[1]

	OP Pr(y=1)	**ZIOP[2] Pr(y=1)**	**OP Pr(y=2)**	**ZIOP Pr(y=2)**
Male	0.011	0.034	0.016	0.005
	(0.016)	(0.026)	(0.022)	(0.025)
College	-0.007	-0.004	-0.010	-0.013
	(0.018)	(0.032)	(0.028)	(0.031)
Age	-0.015***	-0.011	-0.021***	-0.018*
	(0.005)	(0.010)	(0.007)	(0.008)
Income	0.006	0.012*	0.008	0.003
	(0.004)	(0.008)	(0.006)	(0.007)
Hispanic	0.016	0.040	0.206**	0.162**
	(0.033)	(0.112)	(0.093)	(0.068)
Black	-0.010	-0.024	-0.013	-0.001
	(0.031)	(0.047)	(0.036)	(0.044)
Asian	0.035***	0.005	0.096*	0.094*
	(0.010)	(0.055)	(0.055)	(0.046)
Otherrace	0.021	-0.074	0.176*	0.174*
	(0.030)	(0.085)	(0.103)	(0.085)
Budget	0.024***	-0.003	0.034***	0.039***
	(0.008)	(0.014)	(0.009)	(0.012)
Vegan	-0.002	0.056	-0.002	-0.006
	(0.033)	(0.061)	(0.011)	(0.049)
Knowledge_Immunity	-0.024	-0.042	-0.044	-0.016
	(0.018)	(0.074)	(0.044)	(0.046)
Preventative	0.052**	0.037	0.059***	0.048
	(0.025)	(0.032)	(0.023)	(0.033)
Health_Aware	0.035***	0.054*	0.072*	0.066*
	(0.012)	(0.034)	(0.036)	(0.034)
Taste	0.032***	-0.017	0.044***	0.045***
	(0.009)	(0.013)	(0.009)	(0.012)
Price	0.007	0.001	0.010	-0.001
	(0.008)	(0.006)	(0.011)	(0.012)
Covenience	0.010	-0.012	0.014	0.030*
	(0.008)	(0.011)	(0.011)	(0.015)
Mushroom_health	0.019***	-0.011	0.027***	0.029**
	(0.007)	(0.009)	(0.009)	(0.011)
Diversity	0.003	-0.003	0.005	0.009
	(0.008)	(0.006)	(0.011)	(0.011)

[1] Standard errors are in parentheses; ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively.

[2] ZIOP = zero-inflated ordered probit.

Regression results indicate that consumers' awareness of health benefits of mushrooms is not significant in any model. Consumers' belief that foods can help when sick is not statistically significant except for the binary probit model. However, consumers' knowledge of the effectiveness of mushroom enhancing immunity is significant in both the binary probit model and the ZIOP model. This variable is significant in both participation stage and the consumption stage, but with opposite directions. According to the ZIOP model, consumers who know mushrooms enhance immunity are more likely to try the processed mushrooms but less likely to purchase more frequently.

Table 6. Processed mushroom consumption: marginal effect for non-participation and zero.[1]

	Binary probit	**Ordered probit**	**ZIOP[2] model**		
			Non-participation	**Zero consumption given participation**	**Full zero consumption**
	Pr(y=0)	**Pr(y=0)**	**Pr(r=0)**	**Pr(r=1, d=0)**	**Pr(y=0)**
Male	-0.011	0.023	-0.037	0.051	0.013
	(0.041)	(0.039)	(0.058)	(0.039)	(0.031)
College	0.020	0.066	0.006	0.021	0.027
	(0.049)	(0.049)	(0.067)	(0.043)	(0.036)
Age	-0.028**	-0.004	0.025	-0.016	-0.009
	(0.013)	(0.013)	(0.019)	(0.014)	(0.009)
Income	0.002	0.004	0.026*	-0.017*	-0.009*
	(0.011)	(0.011)	(0.015)	(0.010)	(0.005)
Hispanic	0.063	-0.070	-0.488	0.231	-0.257
	(0.094)	(0.101)	(0.552)	(0.198)	(0.368)
Black	0.122*	0.070	-0.027	0.051	0.024
	(0.063)	(0.066)	(0.157)	(0.106)	(0.067)
Asian	0.069	0.083	0.059	-0.003	0.056
	(0.077)	(0.069)	(0.091)	(0.063)	(0.048)
Otherrace	0.014	0.124	-1.747***	0.637***	-1.111***
	(0.122)	(0.103)	(0.205)	(0.110)	(0.197)
Budget	-0.069***	-0.059***	-0.060***	0.017	-0.042***
	(0.019)	(0.018)	(0.024)	(0.016)	(0.014)
Vegan	-0.133	-0.134*	-1.699	0.480	-1.218
	(0.086)	(0.080)	(4.482)	(4.918)	(3.55)
Knowledge_Immunity	-0.111*	-0.036	-0.241***	0.192***	-0.048
	(0.064)	(0.068)	(0.070)	(0.067)	(0.050)
Preventative	-0.134**	-0.075	-0.027	0.005	-0.022
	(0.046)	(0.049)	(0.066)	(0.046)	(0.032)
Health_Aware	-0.060	0.031	-0.040	0.049	0.008
	(0.054)	(0.052)	(0.078)	(0.052)	(0.040)
Taste	–	-0.033**	–	-0.009*	-0.009*
		(0.017)		(0.005)	(0.005)
Price	–	-0.031*	–	-0.015**	-0.015**
		(0.020)		(0.008)	(0.008)
Covenience	–	-0.044**	–	-0.012	-0.012
		(0.021)		(0.100)	(0.100)
Mushroom_health	–	-0.019	–	-0.008	-0.008
		(0.016)		(0.007)	(0.007)
Diversity	–	0.002	–	-0.008	-0.008
		(0.020)		(0.007)	(0.007)

[1] Standard errors are in parentheses; ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively.

[2] ZIOP = zero-inflated ordered probit.

Table 7. Processed mushroom consumption: marginal effect for non-zero consumption levels.[1]

	OP **Pr(y=1)**	**ZIOP[2]** **Pr(y=1)**	**OP** **Pr(y=2)**	**ZIOP** **Pr(y=2)**
Male	-0.012	0.018	-0.010	-0.032
	(0.021)	(0.034)	(0.017)	(0.016)
College	-0.035	-0.006	-0.031	-0.021
	(0.024)	(0.037)	(0.024)	(0.018)
Age	0.002	0.013	0.002	-0.004
	(0.007)	(0.010)	(0.006)	(0.005)
Income	-0.003	-0.014	-0.002	0.004
	(0.006)	(0.010)	(0.005)	(0.005)
Hispanic	0.036	0.268	0.034	-0.011
	(0.048)	(0.308)	(0.053)	(0.071)
Black	-0.041	0.007	-0.029	-0.031
	(0.041)	(0.084)	(0.025)	(0.035)
Asian	-0.050	-0.035	-0.034	-0.021
	(0.044)	(0.050)	(0.025)	(0.031)
Otherrace	-0.077	0.977*	-0.047	0.133*
	(0.071)	(0.136)	(0.033)	(0.081)
Budget	0.032***	0.034**	0.026***	0.008
	(0.011)	(0.013)	(0.008)	(0.009)
Vegan	0.063**	0.934	0.070	0.283
	(0.032)	(5.696)	(0.049)	(8.864)
Knowledge_Immunity	0.021	0.125*	0.015	-0.077*
	(0.04)	(0.045)	(0.028)	(0.028)
Preventative	0.043	0.016	0.032*	0.006
	(0.027)	(0.036)	(0.019)	(0.020)
Health_Aware	-0.017	0.020	-0.013	-0.028
	(0.030)	(0.043)	(0.022)	(0.021)
Taste	0.018*	0.000	0.015**	0.008*
	(0.010)	(0.003)	(0.008)	(0.005)
Price	0.017*	0.001	0.014*	0.014**
	(0.011)	(0.004)	(0.009)	(0.006)
Taste	0.018*	0.000	0.015**	0.008*
	(0.010)	(0.003)	(0.008)	(0.005)
Covenience	0.024**	0.001	0.019**	0.012
	(0.012)	(0.004)	(0.009)	(0.009)
Mushroom_health	0.011	0.000	0.009	0.008
	(0.009)	(0.003)	(0.007)	(0.006)
Diversity	-0.001	0.000	-0.001	0.008
	(0.011)	(0.003)	(0.009)	(0.007)

[1] Standard errors are in parentheses; ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively.

[2] ZIOP = zero-inflated ordered probit.

Considering mushroom characteristics, results of the regression model indicate that taste and price are the two significant factors influencing the consumption frequency of processed mushrooms. Processed mushrooms with better taste and more reasonable price will significantly increase consumers' consumption frequency. Different from fresh mushrooms, convenience and health benefits are no longer significant in the case of processed mushroom consumption.

The marginal effects again highlight some interesting differences from the ZIOP model to the OP model for some explanatory factors, such as income and consumers' knowledge of mushroom benefits on enhancing immunity. Compared to the OP model where income is not significant, the ZIOP model reveals reserve effects of income on consumption participation, and consumption frequency. As shown in Table 6, an increase in the household income results in a 0.026 increase in the probability of non-participation of processed mushrooms, and a 0.017 decrease in the probability of participation with zero consumption. The prior effect indicates that people with higher income might not prefer eating processed mushrooms, and the latter effect indicates that processed mushrooms are a normal good for the participant. Overall, there is a -0.009 net negative effect on the probability of observing zero consumption for the increase in the household income. Thus, the effect of income on the overall zero consumption is approximately zero as the two impacts counter effect each other in the binary and OP equations. However, more information is obtained by using the ZIOP model.

Another difference was found in the effect of consumers' knowledge about the effectiveness of mushroom enhancing immunity. With a single latent equation, like the OP model and Binary Probit model, we assume that there is a homogenous 'benefit-awareness' effect that affects an individual moving from non-consumers to consumers of processed mushrooms. However, when employing the ZIOP model, we see that consumers' knowledge of the effectiveness of mushroom enhancing immunity will significantly decrease the probability of non-participation (Pr(r=0)) by 0.241, while significantly increasing the probability of zero-consumption (Pr(r=1, y=0)) by 0.192. This appears to indicate that although people's knowledge of mushroom benefits might attract consumers to try processed mushrooms, it does not impact frequency of consumption and might lead to consumers trying the product, but at very infrequent times (hence showing up as potential consumers, but not influence frequency of consumption of frequent consumers).

Regarding the potential unobserved effect, the ZIOP model of the processed mushrooms suggests that there exists a significant negative correlation between the two-stage decisions. Using the ZIOP model, results indicate that actions that might attract people to try processed mushrooms might be successful in getting consumers to sample, but might not be successful in creating regular consumers. This relationship suggests that for the promotion of processed mushrooms, attracting new consumers and then increasing their consumption frequency are entirely different challenges. It also reveals the advantage of using the ZIOP model. Ignoring the possible two different zero generating processes, the correlation between the unobserved factors influencing participation and consumption stages might lead to difficulties in correctly making marketing recommendations.

6. Conclusions

This study contributes to the literature by conducting an in-depth analysis of mushroom consumption, as well as demonstrating the effectiveness of the ZIOP model in food consumption research. In this paper, a ZIOP model was employed to analyze the significant factors influencing consumers' behavior in both the fresh and processed mushroom markets accounting simultaneously for the probability of consumption participation and frequency. The ZIOP model allows us to distinguish between zero observations in the survey data which might come from two different sources: genuine non-consumers and zero-consumption participants (potential consumers). The latter were considered as potential consumers because these zero-consumption participants choose not to consume at the current time, but would potentially consume under different circumstances.

The market for fresh mushroom is larger than that for processed. In our study, the portion of non-consumers of processed mushrooms is 31.3%, compared to 20.3% for fresh mushrooms. However, the percentage of potential consumers of processed mushrooms is larger than that of fresh mushrooms, indicating that the processed mushroom market may have potential if appropriate marketing strategies are applied.

Considering the factors influencing mushroom consumption, our study indicated that the reasons driving non-consumers and potential consumers are different, thus emphasizing the contribution of using a model such as the ZIOP, which specifically allows for this distinction. The reasons behind non-consumers are mostly stable demographic attributes like age, income level, consumers' perceptions towards mushrooms and ethnicity – factors that do not change (or do not change quickly). The reasons behind potential consumers are more related to economic reasons like food expenditure.

Consumers' knowledge and awareness of the health benefits of mushroom are significant for participation and consumption for both fresh and processed mushrooms. This suggests that a policy of advertising the health benefits of mushrooms would be a good method to encourage mushroom consumption.

What is more, we also find that once consumers make their determination to participate, sensory factors, like taste are important factors influencing consumption frequency. In this case, improvement in taste in the product will likely lead to increased consumption among consumers, but not an increased quantity of consumers in the market.

Comparing strategies for fresh and processed mushrooms: taste, convenience, and health should be the key points promoting fresh mushrooms; while lower prices and better taste would help processed mushroom attract more consumption.

The ZIOP model allows us to look into the interesting difference of some explanatory factors on the participation stage and consumption stage. A key example is the effect of household income on processed mushroom consumption. In this case, an increase in household income will cause an increase in the probability of non-participation, but a fall in the probability of participation with zero consumption. This latter effect indicates that the processed mushroom is a normal good for participants, although there is a net negative effect on the probability of observing zero consumption for an increase in the household income. However, basing policy advice on the ordered probit model, one would incorrectly conclude that the processed mushroom is an inferior good, and income is negatively related to both participation and higher consumption.

From this study, we could see that the factors influencing potential consumers are different from those influencing non-consumers, and some variables even exert reverse effects on the decisions to participate and the consumption frequency. Thus, there might be structurally different reasons driving non-participants and potential consumers. In the survey design of food consumption studies, to better analyze the market structure and behaviors of different types of consumers, it would be important to not only collect information on consumption and non-consumption, but also the information that differentiates the potential consumers from non-consumers.

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Supplementary material

Supplementary material can be found online at https://doi.org/10.22434/IFAMR2017.0006.

Table S1. Fresh mushroom consumption: regression results.
Table S2. Processed mushroom consumption: regression results.

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Zero-inflated ordered probit approach to modeling mushroom consumption in the United States

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Table S1. Fresh mushroom consumption: regression results.

	Binary probit model		Ordered probit model		ZIOP model			
					Participation		Frequency	
	coeff	*t*-stat	coeff	*t*-stat	coeff	*t*-stat	coeff	*t*-stat
Male	0.234**	2.11	0.072	0.72	0.260	1.40	-0.032	-0.22
College	0.116	0.90	-0.046	-0.37	-0.059	-0.27	-0.052	-0.30
Age	0.006	0.17	-0.096**	-2.90	-0.127**	-1.99	-0.066	-1.15
Income	0.062**	2.09	0.038	1.39	0.097*	1.73	-0.008	-0.18
Hispanic	0.055	0.21	0.706***	2.71	0.741	0.89	0.693**	2.23
Black	-0.314*	-1.80	-0.062	-0.35	-0.178	-0.55	0.032	0.13
Asian	0.686**	2.66	0.374**	2.00	0.296	0.76	0.423*	1.77
Otherrace	0.548	1.54	0.614**	2.07	-0.058	-0.13	0.941**	2.15
Budget	0.145**	2.82	0.155***	3.34	0.081	0.89	0.187***	3.06
Vegan	0.085	0.35	-0.011	-0.05	0.389	0.83	-0.132	-0.52
Knowledge_Immunity	0.057	0.33	-0.187	-1.08	-0.372	-0.72	-0.008	-0.03
Preventative	0.478**	3.88	0.293**	2.45	0.392*	1.86	0.165	0.83
Health_Aware	0.606***	3.79	0.299**	2.19	0.558**	2.21	0.211	1.07
Taste	-		0.202***	4.70	-		0.244***	4.28
Price	-		0.046	0.94	-		-0.004	-0.07
Convenience	-		0.064	1.22	-		0.162**	2.09
Mushroom_health	-		0.122***	2.95	-		0.156***	2.82
Diversity	-		0.022	0.45	-		0.046	0.74
Constant	-1.03**	-3.67			0.740	0.97	-2.110*	4.37
Threshold			3.48***	6.70			2.099**	8.42
Rho(u,e)					0.150	0.20		
# of obs	648		648		648			
Log-likelihood	-382.2		-525.3		-513.2			
Wald TestX_2	76.83(df=13)		233.22(df=18)		161.13(df=18)			

Where *** significant at 1% level, ** significant at 5% level and * significant at 10% level.

Table S2. Processed mushroom consumption: regression results.

	Binary probit model		Ordered probit model		ZIOP model			
					Participation		Frequency	
	coeff	*t*-stat	coeff	*t*-stat	coeff	*t*-stat	coeff	*t*-stat
Male	0.027	0.26	-0.060	-0.59	0.124	0.64	-0.313	-1.67
College	0051	-0.40	-0.169	-1.37	-0.019	-0.09	-0.155	-0.76
Age	0.073**	2.20	0.0108	0.33	0.087	1.29	-0.072	-1.11
Income	-0.004	-0.14	-0.012	-0.44	-0.088*	-1.71	0.077*	1.69
Hispanic	-0.162	-0.65	0.178	0.71	1.645	0.88	-0.843	-1.62
Black	-0.322*	-1.85	-0.186	-1.04	0.104	0.19	-0.279	-0.56
Asian	-0.179	-0.88	-0.222	-1.17	-0.196	-0.65	-0.070	-0.21
Otherrace	-0.035	-0.11	-0.341	-1.11	0.956	1.32	-1.65**	-2.84
Knowledge_Immunity	0.291*	1.65	0.094	0.52	0.810**	3.17	-.976**	-3.56
Preventative	0.348**	2.82	0.197	1.61	0.089	0.41	-0.010	-0.03
Health_Aware	0.152	1.11	-0.0800	-0.59	0.137	0.52	-0.278	-1.13
Budget	0.176***	3.62	0.153**	3.24	0.200***	2.48	-0.027	-0.30
Vegan	0.336	1.54	0.339*	1.68	5.961	0.01	-0.750**	-2.57
Taste	-	-	0.086**	1.96	-	-	0.065*	1.74
Price	-	-	0.081*	1.65	-	-	0.112**	2.11
Covenience	-	-	0.113**	2.10	-	-	0.091	1.31
Mushroom_health	-	-	0.050	1.17	-	-	0.059	1.28
Diversity	-	-	-0.005	-0.11	-	-	0.064	1.19
Constant	-1.39**	-5.03			-1.041	-2.140	0.579	1.08
Threshold			3.118**	6.70	1.254			
Rho(u,e)					-0.907***	-7.945		
# of obs	652		652			652		
Log-likelihood	-422.8		-542.6		-524.4			
Wald testX_2	44.25(df=13)		130.68(df=18)			87.14(df=18)		

Where *** significant at 1% level, ** significant at 5% level and * significant at 10% level.