Emirates Journal of Food and Agriculture. 2022. 34(6): 519-527
doi: 10.9755/ejfa.2022.v34.i6.2895
http://www.ejfa.me/

RESEARCH ARTICLE

The consumer's perceptions and attitudes toward innovative foods in united arab emirates

Aydin Basarir[1]*, Mumin Dayan[2]

[1]College of Agriculture and Veterinary Medicine, UAE University, Al Ain, PO Box 15551, United Arab Emirates, [2]Department of Innovation, Technology and Entrepreneurship, College of Business and Economics, UAE University, Al Ain, PO Box 15551, United Arab Emirates

ABSTRACT

The success of innovations in food industry mainly depends on consumers' involvement in the process. Consumers' trust on developed innovative food products or food production technologies can enhance acceptance/adaptation of them. Consumer acceptance of innovations in general, and technology-based food advances in particular, have been studied extensively. They cover a wide range of facets of the consumer adoption process, from awareness to actual adoption. However, there is a lack of a comprehensive and systematic overview that includes all potentially influential determinants. To fill this gap, we used a conceptual framework for consumer acceptance and adaptation of food innovations. The question needs to be answered is, how consumers perceive sustainable innovations in food products, the way the perception affects their perceived risk & uncertainty, perceived cost/benefit, and attitude strengths toward the innovations? A questionnaire was developed and implemented via stratified random sampling on 400 selected consumers in UAE consumers. Confirmatory factor analysis and a structural equation model (SEM) were used to analyze the general fit of the proposed model and test the developed hypotheses. According to the results the perception of sustainable food innovations is directly affected by some contextual factors (relative advantage, complexity, and observability) determined as product characteristics and mediates the relationship between those factors and consumer adaptation of the innovation which is affected by perceived cost/benefit, perceived risk & uncertainty, and attitudes.

Keywords: Sustainable Food Innovations; Food Perception; Adaption; Risk; Uncertainty; Cost/Benefit

INTRODUCTION

Academic interest in food innovations has grown, and special attention has been given to the factors that may explain consumer acceptance of innovations (Cavaliere and Ventura, 2018). The process of developing a new product, service, market, process, or organization is known as innovation. Innovation can range from "new to the world" (the most innovative) to "new only to the individual" (least innovative) (Knudson, et al., 2004).

Determinants of consumer adoption of innovations have been studied from a variety of perspectives and angles. The literature on food is dominated by a focus on consumer concerns (Capitanio, et al., 2010, Ronteltap, et al., 2007, Zakic, et al., 2008). Consumer concern and acceptance of food innovations shares many similarities with other fields. They do, however, differ in at least one important way: novel foods are actually consumed by the consumer (Rozin, 1999). This could be a good reason why consumer concerns and risk perceptions have received attention in the literature on consumer acceptance of food innovations (Cardello, 2003).

Consumers search for environmentally sustainable and health-oriented innovations in food industry (Samoggia and Nicolodi, 2017). Sustainable innovation is broadly defined as an innovation that must consider environmental and social issues, as well as future generations' needs (Ketata, et al., 2015). Scientists have emphasized the importance of consumers shifting their dietary habits toward levels of consumption that are not only healthy but also sustainable (Verain, et al., 2016). The innovations can be valuable only if they are valuable to consumers (De Kluyver and Pearce, 2006). However, there is a need to comprehend consumer adaptation to food innovations in a broader context (Sarkar and Costa, 2008).

Consumer need and expectations are essential for sustainable food innovations which improve process

***Corresponding author:**
Aydin Basarir, College of Agriculture and Veterinary Medicine, UAE University, Al Ain, PO Box 15551, United Arab Emirates.
E-mail: abasarir@uaeu.ac.ae

Received: 24 September 2021; **Accepted:** 11 May 2022

effectiveness (Estrada, et al., 2016, Zakic, et al., 2008). Consumers may perceive food innovation as either genuine novelty or modifications to already existing products (Guerrero, et al., 2009). A greater variety of consumer needs and a shorter product lifecycle tend to increase competition in the food sector. The food industry is currently evolving into a more consumer-oriented market that necessitates continuous development in order to meet customer expectations (Arcese, et al., 2015). In the food industry, one of the most important factors for increasing competitiveness on both national and international markets is innovation (Grunert, et al., 1997, Kavanagh, et al., 2012). Therefore, the consumer perceptions to food innovations and willing to accept/adapt them are highly important for food firms' successes in the food industry (Siegrist, 2008).

The innovation adaptation process is the mental process by which an individual moves from (1) initial knowledge of an innovation to (2) developing an attitude toward the innovation, (3) deciding whether to adopt or reject the innovation, (4) implementing the new idea, and (5) confirming this decision. During this process, the individual gathers information to gradually reduce risk and uncertainty about the expected outcomes of the innovation. Individuals differ in how long it takes them to progress through the stages (Ronteltap, et al., 2007).

THEORETICAL FRAMEWORK AND MODEL DEVELOPMENT

According to the Rogers' theory (2010), the characteristics of the innovation itself, characteristics of the potential adoptee, and related information all influence the likelihood of a specific individual adopting a specific innovation. Rogers' model is defined at a fairly general level, making it widely applicable but limiting its ability to provide very detailed information in specific cases of innovation. The theory has not been widely applied in the field of food innovation acceptance (Ronteltap, et al., 2007).

Overall, much effort has been expended in modeling consumer adoption and societal diffusion of innovations in general, and technology-based food innovations in particular. They encompass many aspects of the consumer adoption process, ranging from awareness of the innovation to actual adoption (Ronteltap, et al., 2007). However, there is a lack of a comprehensive and systematic overview that includes all potentially influential determinants. We used a conceptual framework for consumer acceptance and adaptation of food innovations to fill this gap (Fig. 1).

In this research, following Rogers (2010), Ronteltap et al. (2007), and Wiedman et al. (2017) A new perception model of sustainable food innovations and adaptation has been used. The conceptual framework incorporates various elements from consumer acceptance theories of sustainable food innovations. To ensure a comprehensive evaluation of consumer adaptation of the innovation, the food product perception, perceived cost/benefit, perceived risk & uncertainty, and attitude strength were chosen as outcomes for the acceptance of innovative food products. The model suggests that:

- The perception of sustainable food innovation is directly affected by contextual factors determined as product characteristics
- The perception of sustainable food innovation mediates the relationship between these factors and consumer adaptation of the innovation which is affected by perceived cost/benefit, perceived risk & uncertainty, and attitudes.

The framework's basic structure is the attitude strength model, but it is expanded to include perceived risk and uncertainty, as well as perceived cost/benefit. The rational cost benefit considerations suggested in the economic literature are included in the perceived cost benefit. Rogers' innovation characteristics appear throughout the model framework. Relative advantage, compatibility, and complexity are primarily concerned with perceived cost-benefit, whereas trialability and observability are concerned with perceived risk and uncertainty (Ronteltap, et al., 2007).

The perception of innovation

A particularly relevant finding from Rogers' (2010) research for anticipating consumer reactions to innovations is the identification of five characteristics of innovations that help to explain differences in adoption rates. These, with clarification of Ronteltap et al. (2007), are:

1. *Relative advantage*: Providing a distinct advantage over previous technologies or methods, whether in terms of economics, convenience, social standing, or satisfaction. Relative advantage can be considered same as attribute characteristics and to be a significant determinant of consumer's attitudes (Davis, 1989, Jiang, et al., 2021). The relative advantage can be hypothesized as:

H1: Relative Advantage of innovative food products has positive effect on the formation of consumer's perception of innovation.

2. *Compatibility*: Fitting in with potential adopters' existing values, past experiences, and needs. When consumers faced with a new innovation they will structure a new attitude and concern whether to use it or not based on their basic needs and wants (Agag and El-Masry, 2016). Therefore, as supported in the literature, there is positive effect of perceived compatibility for consumer's attitudes toward

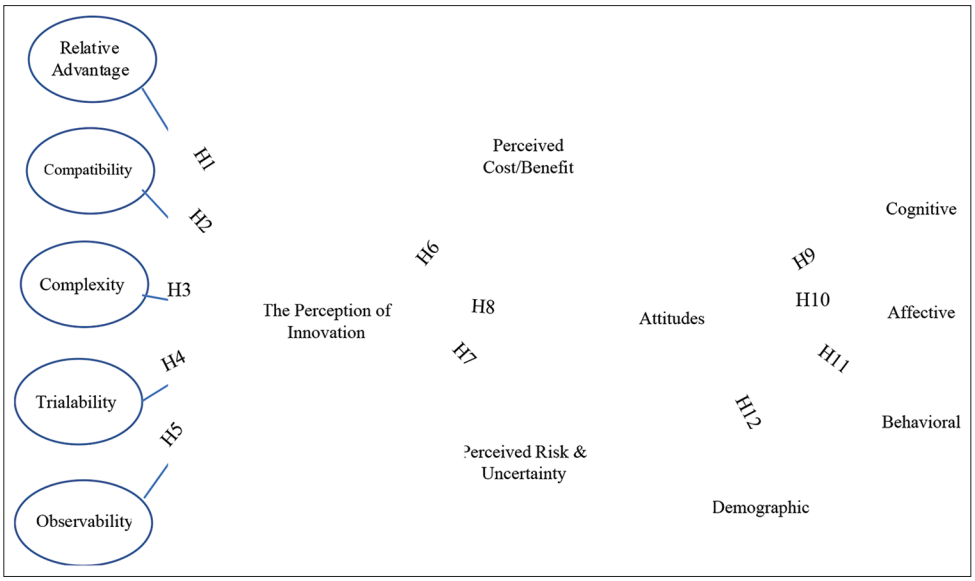

Fig 1. Proposed Model: Modified from Rogers (2010) and Ronteltap et al., (2017) and Wiedman et al. (2010).

adapting an innovation (Agag and El-Masry, 2016, Lee, et al., 2011, Wang, et al., 2018). The Compatibility can be hypothesized as:

H2: Compatibility of innovative food products has positive effect on the formation of consumer's perception of innovation.

3. *Complexity*: The ease of use of an innovation will result in rapid adoption. One of the most important indicators influencing attitudes toward innovation is complexity or perceived ease of use (Agag and El-Masry, 2016, Amaro and Duarte, 2015). The Complexity can be hypothesized as:

H3: Complexity of innovative food products has positive effect on the formation of consumer's perception of innovation

4. *Trialability*: Before adopting an innovation, potential adopters want to be able to experiment with it on a limited basis. The researchers have proved significant impact of trialability on users' attitudes towards innovations by conducting research on different samples of respondents (Al-Rahmi, et al., 2019, Jiang, et al., 2021). The trialability characteristics of an innovative food can allow risk-averse consumers to try and gain confidence in the products before adapting them (Strömberg, et al., 2016). The Trialability can be hypothesized as:

H4: Trialability of innovative food products has positive effect on the formation of consumer's perception of innovation

5. *Observability*: The outcomes of an innovation should be visible and easily communicated to others. Perceived observability can provide a confidence before adapting the innovation (Wang, et al., 2018). The perceived observability can gain consumer's trust by easily learning and familiarizing themselves with the adaptation of the product via observing the other consumers (Jiang, et al., 2021). The Observability can be hypothesized as:

H5: Observability of innovative food products has positive effect on the formation of consumer's perception of innovation.

Perceived cost/benefit

Perceived benefits are reported as a significant factor determining consumer acceptance of an innovations in some research conducted in the literature (Chen and Li, 2007, Ronteltap, et al., 2007). The two most important factors reported are the benefit for consumer's health and benefit to the environment (Samoggia and Nicolodi, 2017). In this study consumer's benefits are analyzed. The consumer is expecting more benefits and minor cost from a food innovation. That is why, the following hypothesis can be conducted as:

H6: The consumer's perception of innovation influences his or her perception of the cost/benefit of innovation.

Perceived risk & uncertainty

Consumers sometimes are unable to estimate the true qualities of innovations, particularly food innovations, because they are primarily either invisible or uncertain (Ronteltap, et al., 2007). That is why, perceive risk and uncertainty related studies has been conducted in many relevant researches in the literature (Cardello, 2003). Consumer perceptions of risk and uncertainty from innovations, as mentioned by Rontaltap (2007), play important roles in acceptance and adaptation specially in the context of life sciences. The

studies support the importance of risk and uncertainty in consumer adaptation to food innovations. Trust in innovation is important for consumer adaptation because it reduces uncertainty and may reduce perceived risk. Thus, the following hypothesis can be conducted as:

H7: The consumer's perception of innovation influences his or her perception of the risk and uncertainty of innovation.

Attitudes

More general attitude strengths can also shape consumer attitudes and intentions toward specific objects. The attitude strengths in the framework can be taken as cognitive, affective, and behavioral (Wiedmann, et al., 2017). These consumer attitude strengths, along with their perceptions, are contained in the framework as more enduring consumer characteristics, which may shape their adaptation through the model's perceived determinants. The following hypotheses can be conducted for attitude strength toward innovation

H8 : The consumer's perception of innovation influences all three components of attitude strength (cognitive, affective and behavioral)

H9: Consumers' attitudes toward food innovation are positively influenced by cognitive strength.

H10: Consumers' attitudes toward food innovation are positively influenced by affective strength.

H11: Consumers' attitudes toward food innovation are positively influenced by behavioral strength.

Demographics

H12: Demographic characteristics of consumer has positive effect on his/her attitude toward food innovation

The main objective of this study is to analyze the effects of sustainable food innovation perceptions on consumer's perceived cost/benefit, risk & uncertainity, and attitudes. As mentioned in the proposed model, the objective will include the analysis of:

- How do consumers percieve sustainable food innovations?
- In what ways does the perception influence consumers' perceived cost/benefit, perceived risk and uncertainty, and attitude strength toward adaptation of innovations?

The most recently developed food innovations (e.g., Functional Food, Extension of shelf life of food products, Vitamin A and D added to milk, Nanotechnology and etc.) were determined and the study was conducted based on consumer perceptions of such innovations. Confirmatory factor analysis and structural equation modeling will be used to analyze the proposed model.

RESEARCH METHOD AND DATA COLLECTION

In order to achieve the study's objective and collect data for the hypotheses' analyses, a questionnaire was developed and implemented via stratified random sampling on 400 selected consumers in UAE via paper-based, web-based, social media, and personal interview. The population was the residents of UAE and the sample was selected from different places of the country to minimize the representation bias. The questionnaire included seven parts: (1) general information about the food innovation technologies, (2) innovative product characteristics, (3) The perception of innovations, (4) perceived cost/benefit, (5) perceived risk & uncertainty, (6) consumer's attitudes toward the innovations, and (7) demographics. The respondents were given a brief explanation for innovative food products and asked to fill the survey based on their experiences with and/or expectations from the products.

Tables 1 and 2 show the demographic characteristics of the respondents. According to Table 1, the vast majority of respondents were male (%57), single (67.5%), have bachelor degree (%67.5), college student (%35), expatriate (%60.6), and live in Abu Dhabi Emirate (%63.5).

As given in Table 2, the age of respondents ranged from 18 to 59 with an average of 28.52. The average household size seems to be ranged between 2 to 5 people. The average

Table 1: Frequency of Some Demographic Characteristics of Respondents

Variables	Characteristics	Number	Percentage
Gender	Male	228	57.0
	Female	172	43.0
Marital Status	Married	129	32.5
	Single	268	67.5
Education Level	Elementary School	7	1.8
	High School	75	18.8
	Bachelor	270	67.5
	Specialization	10	2.5
	Master	27	6.8
	Ph.D.	9	2.3
	Other	2	0.5
Profession	Public sector employee	52	13.0
	Private sector employee	136	34.0
	Self-employed	30	7.5
	Student	140	35.0
	Intern	15	3.8
	Retired	11	2.8
	Informal	3	0.8
	Other	11	2.8
Nationality	Emirati	157	39.4
	Expatriate	241	60.6
The Place of Living	Abu Dhabi	254	63.5
	Dubai	59	14.8
	Sharjah	36	9.0
	Fujairah	29	7.2
	Ras Al Khaimah	9	2.3
	Umm Al Quwain	2	0.5
	Ajman	8	2.0

household monthly income seems to be ranged between AED 15000 to AED 25000.

The observed variables (indicators) and measurement scales used in this study were validated in the relevant literature. Each indicator was assessed using a 5-point Likert scale (1 being the lowest level and 5 being the highest). The summary of observable variables included in each construct (latent variable) is given in Table 3. The respondents were asked to express their opinions using the following codes: SA: Strongly Agree (=5), A: Agree (=4), N: Neutral (=3), D: Disagree (=2), and SD: Strongly Disagree (=1). Demographic indicators were used as continuous variable in the analysis.

Table 2: Deterministic Statistics of Some Demographic Characteristics of Respondents

Variables	#	Min.	Max.	Mean	Std. Deviation
Age of Respondents:	380	18	59	28.52	8.657
Household size: (1) live alone (2) Up to 2 people (3) From 2 to 5 people (4) More than 5 people	400	1	5	2.92	1.041
Monthly Family Income (AED) (1) less then 5000 (2) 5000 – 9999 (3) 10000 – 14999 (4) 15000 – 19999 (5) e) 20000-24999 (6) 25000 – 29999 (7) 30000 – 34999 (8) 35000 – 39999 (9) 40000 – 44999 (10) 45000 – 49999 (11) 50000 and more	390	1	11	4.37	3.074

Table 3: Constructs and Indicators. Source: Authors' Elaboration

Construct (Latent Variables)	Indicators
Relative Advantage (RA)	RA1: Innovative foods have better quality than the traditional foods
	RA2: Innovative foods are more convenient
	RA3: Innovative foods have better nutritious value
Compatibility (CP)	CP1: Innovative foods are environment friendly
	CP2: Innovative foods match my social and cultural lifestyles
	CP3: Innovative foods fit the food industry better than existing ones
Complexity (CX)	CX1: I can easily understand the ingredients, benefit, and features of innovative foods
	CX2: Shorter time is needed to prepare/process innovative foods
	CX3: Innovative foods are similar to the other available foods
Trialability (TR)	TR1: I experience pleasure eating innovative foods
	TR2: I'm willing to try a food product with a longer shelf life.
	TR3: I'm usually one of the first people to try new branded innovative foods.
Observability (OB)	OB1: Food innovation in general is supported by many consumers
	OB2: Innovative foods have enough variety/taste
	OB3: Price plays a key role in buying innovative foods
The Perceptions of Innovations (PR)	PR1: Innovative foods have nutritional benefits
	PR2: Innovative foods have general threat to human health
	PR3: Innovative foods causes creating new species and threats
Perceived Cost/Benefit (PCB)	PCB1: Innovative foods have no negative impact on personal health
	PCB2: Innovative foods provide food security
	PCB3: Innovative foods increase quality of life
Perceived Risk and Uncertainty (PRU)	PRU1: Innovative foods might cause feelings of concern or worry
	PRU2: There is uncertainty about the effects of innovative foods
	PRU3: Overloading new functional properties of foods could produce unpredictable risks
Attitudes (AT)	AT1: I gain complete information about innovative food product before I buy.
	AT2: I am willing to pay more for greener foods.
	AT3: I avoid food containing additives.
Cognitive (CG)	CG1: I am aware of the new innovations in food industry
	CG2: I am aware of the innovative food safety standards & regulations.
	CG3: I am looking for foods which were produced in eco-friendly way
Affective (AF)	AF1: Branded innovative food gives me quality assurance
	AF2: I love to use those foods which have assured labeling.
	AF3: I consider peer reference for healthy food
Behavioral (BH)	BH1: I always consume fresh innovative foods.
	BH2: I am very conscious about my health & buy innovative foods as per that
	BH3: I am very cautious when it comes to trying new and different innovative foods.
Demographic (DM)	DM1: The age of respondent in years
	DM2: The marital status of respondent (1: Married and 0: single)

DATA ANALYSIS AND RESULTS

Confirmatory factor analysis and a structural equation model (SEM) were used to analyze the general fit of the proposed model shown in Fig. 1 and test the hypotheses. SEM has grown in popularity and is widely used in social science literature (Bentler and Dudgeon, 1996). The model is useful in analyzing data collected via survey and evaluating the structural measurement scales' validity, reliability, and predictability (Jiang, et al., 2021). SmartPLS program was used for data analysis.

Common method bias

Harman's single factor test was used to assess common method bias. According to the results of the test, a single factor solution explained only 23.183 percent of the total variance, which is less than the 50% threshold value. Thus, the common method bias should not be regarded as a serious flaw in this study's methodology.

Reliability and validity

The variables' reliability was tested using Composite Reliability (CR). The analysis started with including all samples at the beginning. The items had factor loading less then 0.600 were eliminated. Table 4 represents the factor loadings, reliability, validity and variance inflation factor (VIF) for the remaining items. Despite the fact that a few Alpha values were less than the recommended value of 0.700, the CR values were significantly higher. The average variance extracted (AVE) values were all greater than the 0.500 threshold value, indicating convergent validity. The value of each indicator's VIF was less than 5 critical value to determine multi-collinearity.

Table 5 shows the discriminant validity as measured by cross-loadings. The table includes the cross-factor loadings of all items. All of the factor loadings are greater than their cross-loadings, indicating that discriminant validity is approved. The Fornell and Larcker criterion, indicated in the SmartPLS program, was used to test the validity.

Structural equation model

The hypothesized relationships was analyzed via structural equation model by running bootstrapping in the program. The direct relationships between the indicators were tested first and results in detail are given in Table 6. According to the results, all hypotheses were positive and supported except H2: CP -> PR and H4: TR -> PR. Hypotheses H1, H3, H5, H6, H7, H8, H9, H10, and H11 are thus accepted, while H2 and H4 are rejected.

Following that, mediation analysis was performed, and the results are shown in Table 7. According to the results, PR is mediating the relationship between three product characteristic indicators (RA, CX, and OB). The remaining two indicators (CP and TR) seem to not need mediator to effect the attitude of consumers regarding to innovative food.

DISCUSSION

Consumer perceptions and attitudes toward the innovative foods has been taken as important indicators in development of innovative foods. This study used a few theoretical implications to understand consumer responses toward the products. The methodology developed in this research supports some of the finding of structural equation models utilized in previous

Table 4: Item Loadings, Reliability and Validity Variance Inflation Factor (VIF)

Indicators	λ	Composite Reliability	Average Variance Extracted (AVE)	VIF
RA1	0.826	0.845	0.645	1.433
RA2	0.759			1.372
RA3	0.822			1.501
CP1	0.791	0.859	0.671	1.521
CP2	0.873			1.758
CP3	0.791			1.431
CX1	0.669	0.716	0.457	1.178
CX2	0.661			1.163
CX3	0.697			1.02
TR1	0.752	0.784	0.548	1.18
TR2	0.745			1.181
TR3	0.723			1.199
OB1	0.709	0.773	0.531	1.146
OB2	0.737			1.181
OB3	0.741			1.152
PR1	0.674	0.720	0.461	1.028
PR2	0.674			1.128
PR3	0.689			1.147
PCB1	0.760	0.831	0.622	1.231
PCB2	0.775			1.463
PCB3	0.829			1.575
PRU1	0.789	0.786	0.553	1.312
PRU2	0.798			1.343
PRU3	0.633			1.091
AT1	0.653	0.729	0.473	1.052
AT2	0.738			1.101
AT3	0.671			1.108
CG1	0.773	0.792	0.562	1.824
CG2	0.818			1.838
CG3	0.647			1.038
AF1	0.790	0.822	0.607	1.255
AF2	0.777			1.486
AF3	0.770			1.348
BH1	0.819	0.814	0.597	1.477
BH2	0.841			1.442
BH3	0.642			1.152
DM1	0.899	0.877	0.780	1.461
DM2	0.667			1.461

Table 5: Discriminant Validity using the Fornell & Larcker Method

Var.	AF	AT	BH	CG	CP	CX	DM	OB	PCB	PRU	RA	PR	TR
AF	**0.779**												
AT	0.462	**0.688**											
BH	0.480	0.632	**0.772**										
CG	0.344	0.592	0.508	**0.750**									
CP	0.432	0.327	0.259	0.291	**0.819**								
CX	0.427	0.477	0.392	0.477	0.403	**0.676**							
DM	0.101	0.208	0.142	0.070	-0.033	0.081	**0.883**						
OB	0.359	0.309	0.351	0.335	0.336	0.380	0.017	**0.729**					
PCB	0.440	0.330	0.294	0.350	0.574	0.454	0.027	0.373	**0.789**				
PRU	0.236	0.318	0.246	0.301	0.167	0.349	0.134	0.307	0.211	**0.744**			
RA	0.429	0.359	0.265	0.351	0.546	0.492	0.028	0.335	0.599	0.223	**0.803**		
PR	0.381	0.408	0.363	0.395	0.417	0.470	0.107	0.475	0.556	0.475	0.535	**0.679**	
TR	0.408	0.335	0.350	0.380	0.550	0.505	0.010	0.310	0.498	0.293	0.510	0.411	**0.740**

Table 6: Direct Relationship (Hypotheses H1 to H12)

Hypotheses	β	T Values	P Values	Hypothesis Results
H1: RA -> PR	0.279	5.690	0.000	Supported
H2: CP -> PR	0.060	1.159	0.247	Not Supported
H3: CX -> PR	0.175	3.216	0.001	Supported
H4: TR -> PR	0.056	0.914	0.361	Not Supported
H5: OB -> PR	0.280	5.841	0.000	Supported
H6: PR -> PCB	0.541	11.875	0.000	Supported
H7: PR -> PRU	0.490	9.212	0.000	Supported
H8: PR -> AT	0.412	8.015	0.000	Supported
H9: AT -> CG	0.593	16.504	0.000	Supported
H10: AT -> AF	0.461	9.061	0.000	Supported
H11: AT -> BH	0.633	18.270	0.000	Supported

Table 7: Mediation Analysis (H13)

Hypotheses	β	T Values	P Values	Results
RA -> PR -> PCB	0.151	4.689	0.000	Supported
RA -> PR -> PRU	0.137	5.278	0.000	Supported
RA -> PR -> AT	0.110	4.574	0.000	Supported
CP -> PR -> PCB	0.032	1.13	0.259	Not Supported
CP -> PR -> PRU	0.029	1.164	0.245	Not Supported
CP -> PR -> AT	0.023	1.141	0.254	Not Supported
CX -> PR -> PCB	0.095	3.088	0.002	Supported
CX -> PR -> PRU	0.086	2.787	0.005	Supported
CX -> PR -> AT	0.069	2.679	0.008	Supported
TR -> PR -> PCB	0.030	0.908	0.364	Not Supported
TR -> PR -> PRU	0.027	0.881	0.379	Not Supported
TR -> PR -> AT	0.022	0.894	0.371	Not Supported
OB -> PR -> PCB	0.151	5.191	0.000	Supported
OB -> PR -> PRU	0.137	4.488	0.000	Supported
OB -> PR -> AT	0.110	4.69	0.000	Supported

studies which have developed framework to analyze the consumers' perceptions and attitude toward innovative foods. The study adds answers to the question of how perception of innovation is affected by product characteristics and how mediates such affect to consumer's cost benefit, risk and uncertainty, and attitudes toward innovative foods.

The five product characteristics expected to effect the perception of innovation were analyzed in the model. Even though the beta values for all five product characteristics were positive as supported by Wiedman et al. (2017), and Jiang et al.(2021) the *p* values of TR and CP were not small enough (less than 0.05) to accept H2 and H4 Hypothesis (Table 6). The remaining three hypothesis were accepted as expected.

As indicated above, benefit for consumer's health and benefit to the environment are two related subjects reported in the literature (Samoggia and Nicolodi, 2017). That is why, both benefits were analyzed in this study. Our findings appear to be similar to those of Chen & Li (2007) and Ronteltap et al. (2007), who found that perception of innovation had a positive effect on perceived cost/benefits. Thus, H_6 hypothesis can be easily accepted. It is obvious that the consumers are expecting more benefits and minor cost from food innovations.

Innovations in food are in general hard to realize at the beginning and their impacts on human health takes time to realize. That is why, the perceived risk & uncertainty of innovative food has been concern of many studies in the literature. The studies conducted by Cardello (2003) and Ronteltap (2007) are two well-known researches in the literature. The hypothesized result of the perceived risk & uncertainty (H_7) from innovative food supported the findings of Cardello (2003) and Ronteltap (2007). It seems that the risk and uncertainty are important indicators for consumer adaptation of food innovations. Consumer's trust in innovation can reduce uncertainty/risk and accelerate the adaptation of innovative food.

Attitude strengths taken as cognitive, affective, and behavioral can shape the consumers' attitudes and intension toward food innovations. These consumer strengths and perceptions are contained in the framework as more

enduring consumer characteristics, which may shape their adaptation through the model's perceived determinants. The hypothesized effects of attitudes and the strengths were accepted as expected and supported the finding of Wiedman et al. (2017).

CONCLUSION

This research was based mainly on analysis of primary data collected via survey from stratified randomly selected respondents. The question was about how consumers perceive innovative and sustainable food products, and how that perception influences their perceived risk and uncertainty, perceived cost/benefit, and attitude strengths toward the innovations. According to the results the perception of sustainable food innovation is directly affected significantly by some contextual factors (relative advantage, complexity, and observability) determined as product characteristics and mediates the relationship between these factors and consumer adaptation of the innovation which is affected by perceived cost/benefit, perceived risk & uncertainty, and attitudes. As a result, it can be concluded that the respondents are in general on the favor of accepting and adapting the new innovations in food industry. These results can be useful for food firms in maintaining and strengthening their efforts on developing more sustainable food innovations and services to achieve competitive advantages in today's highly competitive environments.

ACKNOWLEDGEMENT

The authors are grateful to UAEU Research Office for funding project from which this paper came out.

AUTHORS' CONTRIBUTIONS

The authors worked together in preparation of all sections of the manuscript.

REFERENCES

Agag, G. and A. A. El-Masry. 2016. Understanding consumer intention to participate in online travel community and effects on consumer intention to purchase travel online and WOM: An integration of innovation diffusion theory and TAM with trust. Comput. Hum. Behav. 60: 97-111.

Al-Rahmi, W. M., N. Yahaya, A. A. Aldraiweesh, M. M. Alamri, N. A. Aljarboa, U. Alturki and A. A. Aljeraiwi. 2019. Integrating technology acceptance model with innovation diffusion theory: An empirical investigation on students' intention to use e-learning systems. IEEE Access. 7: 26797-26809.

Amaro, S. and P. Duarte. 2015. An integrative model of consumers' intentions to purchase travel online. Tour. Manag. 46: 64-79.

Arcese, G., S. Flammini, M. C. Lucchetti and O. Martucci. 2015. Evidence and experience of open sustainability innovation practices in the food sector. Sustainability. 7: 8067-8090.

Bentler, P. M. and P. Dudgeon. 1996. Covariance structure analysis: Statistical practice, theory, and directions. Annu. Rev. Psychol. 47: 563-592.

Capitanio, F., A. Coppola and S. Pascucci. 2010. Product and process innovation in the Italian food industry. Agribusiness. 26: 503-518.

Cardello, A. V. 2003. Consumer concerns and expectations about novel food processing technologies: Effects on product liking. Appetite. 40: 217-233.

Cavaliere, A and V. Ventura. 2018. Mismatch between food sustainability and consumer acceptance toward innovation technologies among millennial students: The case of shelf life extension. J. Clean. Prod. 175: 641-650.

Chen, M. F. and H. L. Li. 2007. The consumer's attitude toward genetically modified foods in Taiwan. Food Qual. Prefer. 18: 662-674.

Davis, F. D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 13: 319.

De Kluyver, C. A. and J. A. Pearce. 2006. Strategy: A View from the Top. An Executive Perspective. Pearson Prentice Hall, Hoboken, New Jersey.

Estrada, I., D. Faems and P. De Faria. 2016. Coopetition and product innovation performance: The role of internal knowledge sharing mechanisms and formal knowledge protection mechanisms. Ind. Mark. Manag. 53: 56-65.

Grunert, K. G., H. Harmsen, M. Meulenberg, E. Kuiper, T. Ottowitz, F. Declerck, B. Traill and G. Göransson. 1997. A framework for analysing innovation in the food sector. In: Products and Process Innovation in the Food Industry. Springer, Berlin, Germany, pp. 1-37.

Guerrero, L., M. D. Guardia, J. Xicola, W. Verbeke, F. Vanhonacker, S. Zakowska-Biemans, M. Sajdakowska, C. Sulmont-Rosse, S. Issanchou, M. Contel, M. L. Scalvedi, B. S. Granli and M. Hersleth. 2009. Consumer-driven definition of traditional food products and innovation in traditional foods. A qualitative cross-cultural study. Appetite. 52: 345-354.

Jiang, Y., X. Wang and K. F. Yuen. 2021. Augmented reality shopping application usage: The influence of attitude, value, and characteristics of innovation. J. Retailing Consum. Serv. 63:102720.

Kavanagh, G., M. Henchion, M. McCarthy, S. McCarthy and G. Williams. 2012. Technological innovation a route towards sustainability. Int. J. Food Syst. Dyn. 3: 35-49.

Ketata, I., W. Sofka and C. Grimpe. 2015. The role of internal capabilities and firms environment for sustainable innovation: Evidence for Germany. RD Manag. 45: 60-75.

Knudson, W., A. Wysocki, J. Champagne and H. C. Peterson. 2004. Entrepreneurship and innovation in the agri-food system. Am. J. Agric. Econ. 86: 1330-1336.

Lee, S., S. Ha, and R. Widdows. 2011. Consumer responses to high-technology products: Product attributes, cognition, and emotions. J. Bus. Res. 64: 1195-1200.

Rogers, E. M. 2010. Diffusion of Innovations. Simon and Schuster, New York.

Ronteltap, A., J. Van Trijp, R. Renes and L. Frewer. 2007. Consumer acceptance of technology-based food innovations: Lessons for the future of nutrigenomics. Appetite. 49: 1-17.

Rozin, P. 1999. Food is fundamental, fun, frightening, and far-reaching. Soc. Res. 66: 9-30.

Samoggia, A. and S. Nicolodi. 2017. Consumer's perception of fruit innovation. J. Int. Food Agribus. Mark. 29: 92-108.

Sarkar, S. and A. I. Costa. 2008. Dynamics of open innovation in the food industry. Trends Food Sci. Technol. 19: 574-580.

Siegrist, M. 2008. Factors influencing public acceptance of innovative food technologies and products. Trends Food Sci. Technol. 19: 603-608.

Strömberg, H., O. Rexfelt, I. C. M. Karlsson and J. Sochor. 2016. Trying on change trialability as a change moderator for sustainable travel behaviour. Travel Behav. Soc. 4: 60-68.

Verain, M. C., S. J. Sijtsema and G. Antonides. 2016. Consumer segmentation based on food-category attribute importance: The relation with healthiness and sustainability perceptions. Food Qual. Pref. 48: 99-106.

Wang, X., K. F. Yuen, Y. D. Wong and C. C. Teo. 2018. An innovation diffusion perspective of e-consumers' initial adoption of self-collection service via automated parcel station. Int. J. Logist. Manag. 29: 237-260.

Wiedmann, K. P., L. Albertsen, S. Langner, E. Karampournioti and S. Schmidt. 2017. Consumer's Perception of Sustainable Food Innovations: Effects on Perceived Risk, Perceived Benefit, and Attitude Strength. Paper presented at 2017 AMA Summer Marketing Educators' Conference Innovations and Sustainability in Marketing, San Francisco, CA.

Zakic, N., A. Jovanovic and M. Stamatovic. 2008. External and internal factors affecting the product and business process innovation. Econ. Organ. 5: 17-29.