



ARTICLE

The Effect of Sustainability-Related Information on the Sensory Evaluation and Purchase Behavior towards Salami Products

Jihe Hwang¹, Seoyoun Lee¹, Minwoo Jo¹, Wanil Cho², and Junghoon Moon^{1,*}

¹Department of Agricultural Economics and Rural Development, Seoul National University, Seoul 08826, Korea

²Sensometrics Inc., Seoul 07217, Korea



OPEN ACCESS

Received July 22, 2020

Revised September 11, 2020

Accepted September 23, 2020

*Corresponding author : Junghoon Moon
Department of Agricultural Economics and Rural Development, Seoul National University, Seoul 08826, Korea
Tel: +82-2-880-4722
Fax: +82-2-873-5080
E-mail: moonj@snu.ac.kr

*ORCID

Jihe Hwang
<https://orcid.org/0000-0001-9722-055X>
Seoyoun Lee
<https://orcid.org/0000-0002-7972-6984>
Minwoo Jo
<https://orcid.org/0000-0003-2991-9363>
Wanil Cho
<https://orcid.org/0000-0003-4589-0468>
Junghoon Moon
<https://orcid.org/0000-0001-7682-7854>

Abstract Consumer's interest in sustainable livestock farming methods has grown in response to concerns for the environment and animal welfare. The purpose of this study is to examine the different influences of sustainability product information on sensory characteristics and purchase behaviors. To accomplish this aim, the study used salami, which is an Italian-style sausage processed by fermentation and drying. Three different types of information were provided: salami made from the pork of an antibiotic-free pig (SMAFP), of an animal welfare pig (SMAWP), and of a grazing pig (SMGP). This study was conducted as an off-line experiment with Korean participants (n=140). As a result, there were sensory differences according to the sustainability information. For the SMAFP, it had a significant difference in, sourness ($p<0.05$). With the SMAWP, there was a difference in gumminess ($p<0.10$), and the SMGP had significant differences in sourness ($p<0.01$), sweetness ($p<0.01$), and moisture ($p<0.05$). Moreover, the purchase intention and willingness to pay were significantly higher when the sustainability information was given. Especially, among the three types of salamis, participants were willing to pay the most for the SMAWP. This is one of the first consumer studies to investigate sensory evaluation and purchase behavior for various types of sustainable livestock production. These results contribute by helping sustainable meat producers and marketers become aware of the kind of sustainable information to which consumers are sensitive.

Keywords information effect, sustainable livestock, sensory evaluation, willingness to buy

Introduction

The livestock industry faces various ethical issues related to environmental and animal welfare concerns (Verbeke et al., 1999). The global livestock production system is characterized by a competitive business climate and has many side effects that are unsustainable for human health, the environment, and animal welfare (Pluhar, 2010). Current livestock production is advantageous for meeting the high demand for meat

at a low price, and the industry has been designed to make it faster and easier than ever to raise livestock (Anomaly, 2015; Williams, 2008). However, animals raised in a conventional livestock production system often do not have enough room to walk and live comfortably in their strictly controlled environments (Appleby et al., 2004), which is closely related to animal welfare issues. Some consumers who are concerned with these issues have shown a preference to purchase meat farmed sustainably (Aiking et al., 2006; Kumar et al., 2017; Webster, 1994). When consuming meat or dairy products, consumers have begun showing more consideration for how livestock is raised (Conner and Oppenheim, 2008; Prickett, 2008; Schnettler et al., 2008). Following this trend, the meat market is changing to meet the needs of consumers by not overusing antibiotics and improving food animals' welfare and rights (Capper, 2013).

Sustainable agriculture and livestock

The importance of sustainable agriculture should also be highlighted because of the concerns about resource shortages caused by global development and population growth (Gomiero et al., 2011; Horrigan et al., 2002). Although many works in the literature deal with sustainable agriculture and have attempted to devise exact definitions for these terms, the meaning of "sustainable agriculture" is dependent on what "sustainable" and "agriculture" actually means (Yunlong and Smit, 1994). Sustainable agriculture and livestock are complex concepts (Pretty, 1995) and should include diverse aspects, such as economic, environmental, and public welfare concerns (Allen et al., 1991). As interest in sustainability increases, breeding animals in a sustainable way has also received greater attention (Thompson and Nardone, 1999). Many developed countries are striving for sustainable livestock production systems by imposing laws and regulations (Ingenbleek et al., 2012; Mench, 2008). For instance, in the U.S., there are two federal laws, the Twenty-Eight Hour Law and the Humane Methods of Slaughter Act that regulate how to treat food animals sustainably (Mench, 2008). Moreover, the Royal Society for the Prevention of Cruelty to Animals (RSPCA) imposed certification schemes called Freedom Foods on animal welfare products in the U.K. These regulations and certifications have also led to significant changes throughout the world to certify that high levels of animal rights are observed during the farming process. There are several ways to make livestock farming more sustainable. Grazing livestock, also called pasture-based or pastoral farming, refers to raising livestock without a fence in a sustainable way (Bernués et al., 2011).

In Korea, there are also several certifications, including a farm animal welfare certification, which ensures that livestock are raised with sufficient nutrition and without unnecessary stress (Kim et al., 2013), and an antibiotic-free livestock certification, which indicates that livestock feed contains no antibiotics or hormones (Ahn et al., 2014). Thus, the raising methods can be categorized into three different types: antibiotic-free, farm animal welfare, and grazing livestock. However, there is little integrated research that has examined how and if consumers have different perceptions depending on the way livestock is raised.

Sustainable products and consumer research

Some previous studies have included experiments related to sustainable food production and consumer research, and there is a growing influence of sustainability-related labels in the global market. According to Siegrist et al. (2015), consumers who think that reducing their meat consumption is good for animals' welfare tend to think that reducing their meat consumption has benefits for the environment. This finding could affect consumers' purchase intentions and provide a positive direction for animal welfare efforts. One experiment on consumers' preference and willingness to pay (WTP) for organically produced beef showed the effects of information spread on organic farming (Napolitano et al., 2010). The study's results addressed

consumers' awareness of organic farming benefits related to production safety and ethics and demonstrated that this information increased their expectations for liking and WTP significantly. In terms of sustainable labels, consumers who perceived the existence of more environmental and social problems tended to be deeply involved in sustainable issues and purchased WTB sustainable products (Sirieix et al., 2012). Moreover, concerns related to the agricultural production process affected consumers' attitudes toward their intention to buy meat products from sustainable farming systems (Burnier and Spers, 2019; Stampa et al., 2020). Although, previous studies have suggested that there is a positive relationship between consumer behaviors and sustainable products, consumer research related to various sustainable farming methods has been limited. Thus, an integrated view of livestock production issues is needed.

Information effects on food choice

Food choices and preferences include a complex process that is related to the evaluation of sensory attributes (e.g., appearance, taste, smell, and texture) and extrinsic cues (e.g., price and information). In addition, consumers' values and beliefs have a major impact on their purchase and consumption decisions (Finch, 2006). Cardello (1994) explained that a food-related behavior model demonstrated the process of receiving food and making related decisions. According to Cardello's model, food is regarded as a sensory stimulus, as it includes taste, smell, texture, and visual components. Moreover, when perceiving foods, consumers interact with various elements and sensory stimuli to create food experiences.

Many factors influence the acceptance of food, but what the present study is particularly interested in is the effects of information about food. Based on this research model, we investigated the relationship between the information provided about a food and consumers' purchase behaviors. Previous studies have conducted experiments on the relationship between information and the consumer valuation of the products. According to Pohjanheimo and Sandell (2009), product information, such as a manufacturer's name, brand name, and so on, positively affects hedonic scores in every evaluation of drinking yogurt. Further, the word "organic" has been shown to increase consumers' liking of and preference for organic bread (Annett et al., 2008). The availability of nutritional and health information also has a positive influence on food choices (Hellyer et al., 2012).

Very few studies to date have dealt with the relationships between various types of sustainable livestock production systems and information cues. Moreover, the exact reasons why consumers' purchase behaviors change in a positive manner have yet to be clearly demonstrated. Therefore, we integrally investigated the relationship between the sensory evaluation and information effects of three animal-raising methods. The aims of this study were: (1) to show the difference in sensory evaluations depending on the presence or absence of information and (2) to figure out the most efficient way to raise livestock that affects consumers' purchase behaviors. In this study, we identified three types of sustainable livestock production systems (antibiotic-free, farm animal welfare, and grazing livestock) and conducted an experiment to figure out the differences between them in consumers' minds based on information effects.

Materials and Methods

We conducted the experiments in two separate parts. The consumer panel procedures were approved by the Seoul National University Institutional Review Board (IRB No. 1905/003-005). The participants were recruited with help-wanted advertisements in an online bulletin board. The population targeted for this study consisted of participants in their 20s and 30s. The pilot tests were also conducted in two separate periods for salami made of pork from antibiotic-free pig (SMAFP)

(n=5) in January of 2019 and for salami made of pork from animal welfare pig (SMAWP) and salami made of pork from grazing pig (SMGP) (n=10) in March of 2019 in order to finalize the experimental design.

Material

Products were obtained from Johncook Deli Meats, which is one of the processed-meat companies producing ham, sausage, bacon, barbecue, etc. in Korea. Three types of salami samples were used made from antibiotic-free pigs feeding natural ingredients, animal welfare pigs, and grazing pigs. This study selected salami as it contributes to the creation of high added-value products by processing pork legs, which are usually non-preferred parts.

Samples were offered to the participants immediately after receiving the cut salami. Salami samples (a semicircle with a radius of 1.5 cm and height of 0.3 cm) were given to the participants (two pieces per person). Participants were instructed to rinse their mouths with tepid water after tasting a sample.

The salami used in this study was a type of Italian-style cured salami that is processed by fermentation and drying. We especially focused on three kinds of pork that were from antibiotic-free, farm animal welfare, and grazing pigs. These salamis were used to estimate the association among sustainable information, sensory evaluation, and purchase behaviors.

Experiment design

The experiment was conducted as a within-subject design. The participants were randomly assigned to 12 groups to minimize the ordering effects. All the experiments had four situations (two samples * with/without information). Table 1 and Fig. 1 show a summary of the experiment design. The experiment was planned in two tests. In the first test, the participants received SMAFP (S641, S492) and SMPG (S537, S189) which were not analysis targets and in the second test, they were offered SMAWP (S518, S117) and SMPG (S948, S179) according to randomization to minimize ordering effects.

The survey consisted of two parts, and all the constructs were selected and transformed from previous research. The first part dealt with sensory evaluation including flavor and texture attributes. The sensory test questionnaire was first created from previous literature about fermented sausage sensory properties (Cenci-Goga et al., 2008; Marangoni and de Moura, 2011), and we then modified the items by expert sensory panels. Finally, 12 sensory features were selected with five tastes, four flavors, and three textures. Table 2 shows the definition of each profile and the additional meanings used in the survey. The sensory properties were measured by a 7-point Likert scale (1="never" to 7="extremely"). The second part was related to

Table 1. Summary of the experimental design

Test	Situation			Analysis target	Number of participants	Period
	Number	Raw material	Information			
1	641	Antibiotic-free	Yes	Yes	50	January 2019
	492	Antibiotic-free	No	Yes		
	537	Grazing	Yes	No		
	189	Grazing	No	No		
2	518	Farm animal welfare	Yes	Yes	90	March 2019
	117	Farm animal welfare	No	Yes		
	948	Grazing	Yes	Yes		
	179	Grazing	No	Yes		

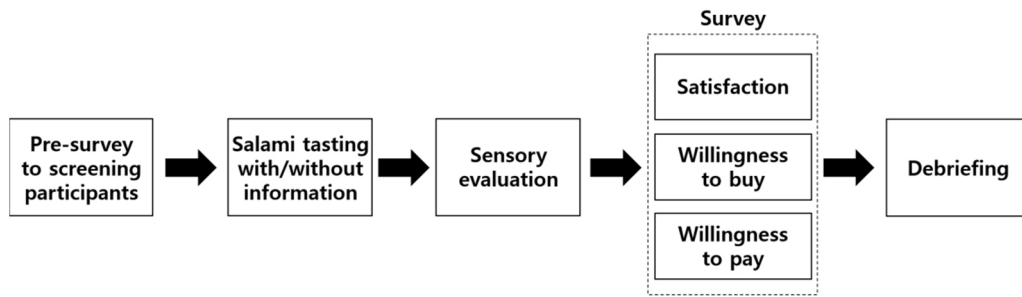


Fig. 1. Summary of the experimental design.

Table 2. The definitions of the sensory profiles

	Profile	Definition	The additional meanings we used	Reference
Flavor	Salty	Taste elicited by salts	Taste when you eat salt	Maughan et al., 2012, p. 117
	Sour	Taste elicited by acids	Taste when you eat vinegar	Maughan et al., 2012, p. 117
	Sweet	Taste elicited by sugar	Taste when you eat sugar	Maughan et al., 2012, p. 117
	Umami	Fundamental taste sensation of which MSG is typical	Taste that attracts appetite	Hwang and Hong, 2013, p. 116
	Nutty	Aromatics associated with nuts such as peanut or walnut	Taste from roasted sesame oil	Hwang and Hong, 2013, p. 116
Odor	Milky	Odor of whipping milk	Odor from milk or powdered milk	Kaaki et al., 2012, p. 523
	Cheesy	Odor of yellow ripened cheese, resemblance to the odor of Parmesan cheese powder	A luxurious odor of fermentation	Jinjarak et al., 2006, p. 2431
	Rancid	Odor associated with oxidized oils/old butter	Unpleasant odors of fermentation	Jinjarak et al., 2006, p. 2431
	Fishy	The aromatics or volatiles which are derived from fish products perceived by smell	A nauseous smell from raw beans or fish	Ritthiruangdej and Suwonsichon, 2006, p. 183
Texture	Gummy	Denseness that persists throughout mastication or the energy require to disintegrate a semisolid food to a state ready for swallowing	The power required to crush semi-solid foods enough to swallow	Cardello et al., 1982, p. 1191
	Moist	Degree of fluids present in the sample mass during the first 3–5 chews	The amount of moisture detected on the sample surface	Lyon, 1980, p. 1342
	Mouth-coating	Degree to which the mouth remains coated after expectoration	The degree of fat or oil coated on the mouth after chewing the sample	Jinjarak et al., 2006, p. 2431

purchase behavior including satisfaction, willingness to buy, and price premium. The satisfaction scale was adopted from Juhl et al. (2002) and dealt with consumers' satisfaction and loyalty in European food retailing; we changed the words to suit salami-purchasing situations. The willingness-to-buy scale was selected and transformed from Dodds et al. (1991)'s measurements. Those two questionnaires were answered using a five-point Likert scale (1="strongly disagree" to 5="strongly agree"). The price premium question stated the price of the original price of salami (200 g), and we asked respondents to answer the price they were willing to pay for the new salami. In social science studies, a significance level of 0.1 is often used to verify whether a factor is significant. Several studies dealing with sensory evaluation showed not only the level of 0.05 but

also 0.1 statistically significant testing (Chakraborty et al., 2011; Moloney et al., 2011; Mudgil et al., 2017; Sánchez-Moliner and Arnau, 2010), so this study also indicated up to the level of 0.1.

Results

General characteristics of the participants

The demographic profile of the respondents that participated in the experiment is presented in Table 3. The study sample consisted of 22 males and 28 females in Group 1 (n=50) and 44 males and 46 females in Group 2 (n=90) for a total of 140 participants.

Sensory evaluation

The collected data were averaged and analyzed using principal component analysis (PCA). Fig. 2 is a sensory map of the results of the PCA in which 80% of the variance was explained. It demonstrates the characteristics of the samples. The PCA map depicts three groupings of salami samples based on the ways the pigs were raised, with the sensory attributes noted accordingly. The sensory map shows how a salami's flavors, odor, and texture changed according to the effects of the revealed information.

Salami Made from Antibiotics-Free Pigs (SMAFP)

The SMAFP in both the blind (S492) and revealed conditions (S641) were characterized as salty, gummy, and sour. The participants perceived salami to be saltier without any given information (S492). The results show that participants considered salami to be less salty when they had information about its antibiotic-free nature (S641).

Salami Made from Animal Welfare Pigs (SMAWP)

The SMAWP in both the blind (S117) and revealed conditions (S518) were grouped and characterized by sensory attributes that include milky, mouth-coating, and cheesy. The SMAWP with the information given (S518) had a stronger cheesy flavor,

Table 3. General characteristics of the participants

Item		Group 1 (n=50)		Group 2 (n=90)	
		Frequency (n)	Percentage (%)	Frequency (n)	Percentage (%)
Age	20–29	34	68	62	68.9
	30–39	13	26	14	15.6
	40–49	3	6	14	15.6
Gender	Male	22	44	44	48.9
	Female	28	56	46	51.1
Occupation	Undergraduate/ grad. student	40	80	45	50
	Office worker	8	16	37	41.1
	Job seeker	-	-	7	7.8
	Stay at home	2	4	1	1.1

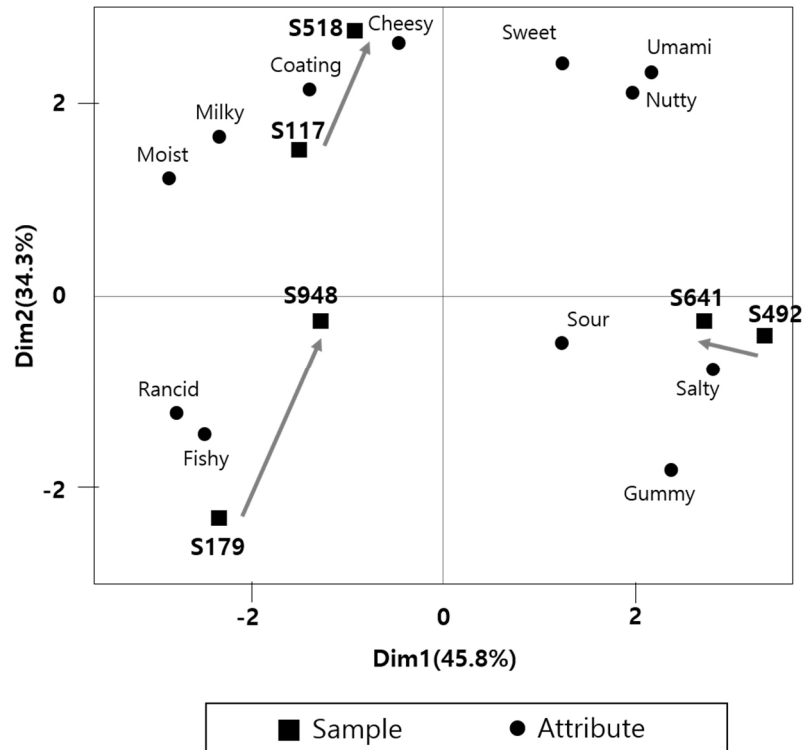


Fig. 2. Principal component analysis of the sensory profile of the salami samples.

while the SMAWP without information (S117) had a stronger milky flavor. It can be interpreted that when the information was revealed concerning the pigs' animal welfare conditions, participants perceived it to have stronger cheesy odor than milky odor.

Salami Made from Grazing Pigs (SMGP)

The SMGP in both the blind (S179) and revealed conditions (S948) were characterized as rancid and fishy. For the SMGP with the revealed information (S948), participants rated the salami as sourness and sweetness, compared to the salami without any given information (S179).

Measurement of sensory evaluation and purchase behavior

To statistically examine the changes in the ratings of the flavor, odor, and texture and the consumers' preferences based on the blind and informed conditions, this study conducted paired t-tests to compare the results. We found minor changes in flavors and texture based on the product information, but noted that participants reported higher satisfaction levels and a heightened willingness to buy and pay more in the informed condition.

Salami Made from Antibiotics-Free Pigs (SMAFP)

For the SMAFP, there was a significant difference ($p < 0.05$) in flavor (Table 4). In contrast to the salami made from the pork of grazing pigs, the participants considered this salami to be more sour in the blind condition (S492). The participants had a higher purchase intention ($p < 0.1$) and WTP for the salami in the informed condition ($p < 0.01$) (Table 5). They were willing to pay more, about 647 Korean won (60 cents USD), for the 200 g of salami when the information was revealed. In

Table 4. The results of the sensory evaluation for the SMAFP

Sensory variables		n	Average scores 0–7 scale (standard deviations in parentheses)		Comparison of individual scores between blind and informed conditions	
			Blind test (B _n) S492	Informed test (I _n) S641	B _n –I _n	p-value
Flavor	Salty	50	5.80 (0.90)	5.60 (1.20)	0.200	0.255
	Sour	50	3.34 (1.53)	2.86 (1.25)	0.480	0.018
	Sweetness	50	3.34 (1.21)	3.36 (1.31)	–0.020	0.916
	Nutty	50	5.08 (1.24)	5.30 (1.28)	–0.220	0.207
	Umami	50	5.30 (0.10)	5.30 (0.10)	0.000	1.000
Odor	Milky	50	4.22 (1.45)	4.38 (1.40)	–0.160	0.364
	Cheesy	50	4.92 (1.47)	4.74 (1.32)	0.180	0.351
	Rancid	50	2.78 (1.31)	2.84 (1.45)	–0.060	0.659
	Fishy	50	2.96 (1.39)	2.94 (1.48)	0.020	0.916
Texture	Gumminess	50	5.72 (1.23)	5.52 (1.23)	0.200	0.327
	Moisture	50	3.80 (1.20)	3.98 (1.13)	–0.180	0.361
	Mouth-coating	50	5.06 (1.30)	4.82 (1.19)	0.200	0.255

SMAFP, salami made from antibiotics-free pigs.

Table 5. The results of the purchase behavior for the SMAFP

Variables	n	B _n –I _n	t-value	p-value
Satisfaction	50	–0.127	–0.889	0.376
Purchase intention	50	–0.253	–1.680	0.096
Willingness to pay	50	–647.00	–2.879	0.005

SMAFP, salami made from antibiotics-free pigs.

contrast, there was no difference in terms of the consumers' satisfaction for this salami between the blind and informed conditions.

Salami Made from Animal Welfare Pigs (SMAWP)

For the SMAWP, there was a difference in texture and gumminess ($p < 0.1$), and participants considered the salami to be gummier in the blind condition (Table 6). Moreover, there was a significant difference in their satisfaction ($p < 0.1$), purchase intention ($p < 0.05$), and WTP more ($p < 0.01$) based on the effects of the revealed information (Table 7). According to these results, the participants showed high levels of satisfaction and purchase intention for salami in the informed condition. Participants were willing to pay more, about 868 Korean won (80 cents USD), for 200 g of the salami in the informed condition.

Salami Made from Grazing Pigs (SMGP)

Lastly, for the SMGP, there were significant differences ($p < 0.01$) in the flavor and texture between the salamis in the blind and informed conditions (Table 8). Participants considered the salami to be more sour, sweet, and moist when its information was revealed. Additionally, the participants had higher satisfaction levels ($p < 0.1$), purchase intention ($p < 0.05$), and were more

Table 6. The results of the sensory evaluation for the SMAWP

Sensory variables		n	Average scores 0–7 scale (standard deviations in parentheses)		Comparisons of individual scores between blind and informed conditions	
			Blind test (B _n) S117	Informed test (I _n) S518	B _n –I _n	p-value
Flavor	Salty	90	5.22 (1.32)	5.10 (1.13)	0.122	0.392
	Sour	90	2.93 (1.39)	2.81 (1.27)	0.122	0.354
	Sweetness	90	3.31 (1.49)	3.40 (1.44)	–0.094	0.491
	Nutty	90	5.03 (1.18)	5.20 (1.15)	–0.167	0.163
	Umami	90	5.17 (1.18)	5.32 (0.99)	–0.1487	0.239
Odor	Milky	90	4.50 (1.45)	4.59 (1.37)	–0.089	0.542
	Cheesy	90	4.99 (1.34)	5.04 (1.27)	–0.056	0.698
	Rancid	90	3.11 (1.69)	3.11 (1.66)	0.000	1.000
	Fishy	90	3.13 (1.53)	2.99 (1.54)	0.144	0.329
Texture	Gumminess	90	5.02 (1.23)	4.78 (1.22)	0.244	0.099
	Moisture	90	5.30 (0.99)	5.17 (1.01)	0.133	0.250
	Mouth-coating	90	5.39 (1.18)	5.23 (1.01)	0.156	0.305

SMAWP, salami made from animal welfare pigs.

Table 7. The results of the purchase behavior for the SMAWP

Variable	n	B _n –I _n	t-value	p-value
Satisfaction	90	–0.222	–1.083	0.073
Purchase intention	90	–0.325	–2.335	0.021
Willingness to pay	90	–868.738	–3.894	0.000

SMAWP, salami made from animal welfare pigs.

willing to buy in the informed condition ($p < 0.01$) (Table 9). They were willing to pay more, about 637 Korean won (60 cents USD), for the 200 g of salami when the information was revealed.

Discussion

As realizing the ethical issues on meat consumption, consumers have lots of interest in sustainable livestock. Due to increasing levels of interest in sustainable agriculture in recent years, many previous papers have started to look at the sustainable livestock systems in terms of economical, environmental, purchase behavior, and so on (Garcia et al., 2017; Kaufmann, 2015; Lebacqz et al., 2013). There are, however, little research has investigated the types of sustainable livestock in terms of consumer behavior. This study was the first to conduct a sensory evaluation regarding the three kinds of animal raising styles and to identify the effects of revealing the information on purchase behavior.

The main purpose of this study was to investigate the effect of sustainability-related information on sensory evaluations and consumers' purchase behaviors. Existing papers dealing with meat and sustainability-related information collected the data only through surveys to investigate consumers' characteristics or factors affecting purchase intentions (Hoek et al., 2017; Mohr and Schlich, 2015). Thus, this study added sensory experiments to understand consumers' purchase behavior more deeply.

Table 8. The results of the sensory evaluation for the SMGP

Sensory variables		n	Average scores 0–7 scale (standard deviations in parentheses)		Comparison of individual scores between blind and informed conditions	
			Blind test (B _n) S179	Informed test (I _n) S948	B _n –I _n	p-value
Flavor	Salty	90	5.21 (1.29)	5.37 (0.99)	–0.156	0.154
	Sour	90	2.88 (1.43)	3.27 (1.44)	–0.390	0.005
	Sweetness	90	2.98 (1.27)	3.41 (1.36)	–0.433	0.001
	Nutty	90	4.68 (1.20)	4.89 (1.29)	–0.211	0.110
	Umami	90	4.70 (1.35)	4.89 (1.33)	–0.189	0.107
Odor	Milky	90	4.37 (1.52)	4.58 (1.41)	–0.211	0.164
	Cheesy	90	4.70 (1.47)	4.93 (1.23)	–0.233	0.111
	Rancid	90	3.53 (1.70)	3.36 (1.65)	0.178	0.155
	Fishy	90	3.23 (1.48)	3.19 (1.53)	0.043	0.784
Texture	Gumminess	90	5.28 (1.17)	5.29 (1.14)	–0.011	0.941
	Moisture	90	4.72 (1.17)	4.97 (1.16)	–0.244	0.048
	Mouth-coating	90	4.96 (1.33)	5.03 (1.13)	–0.078	0.628

SMGP, salami made from grazing pigs.

Table 9. The results of the purchase behavior for the SMGP

Variable	n	B _n –I _n	t-value	p-value
Satisfaction	50	–0.211	–1.760	0.080
Purchase intention	50	–0.348	–2.450	0.015
Willingness to pay	50	–637.401	–2.965	0.003

SMGP, salami made from grazing pigs.

Before analyzing the effects of revealing information, this study used PCA and found that salami produced from pork using three different animal raising methods—antibiotic-free, farm animal welfare, and grazing—had different sensory attributes. From these results, we can state that consumers perceived the taste of salami produced from farm animal welfare pork to be milky, mouth-coating, and cheesy. Salami made from the antibiotic-free pork was characterized by its saltiness, gumminess, and sourness. Lastly, participants perceived salami made from the pork of grazing pigs as rancid and fishy.

The absence or presence of information had a significant effect on the consumers' purchase behaviors, which included satisfaction, purchase intention, and WTP. Participants were willing to pay more for salami in all three informed conditions. This result indicates that consumers believe salami made from pigs that are raised in a sustainable environment and using humane methods is usually more expensive and valuable than other salami. The results of this study are consistent with de-Magistris and Gracia (2016) and motivates for producers to do sustainable agriculture. Several studies also demonstrated that consumers have an increasing interest in farming practices and show their WTP more for products obtained using sustainable production systems (Dransfield et al., 2005). Participants showed high satisfaction and purchase intention in the informed condition for salami made from both the animal welfare and grazing pigs. It is the first time we know a paper that investigated the way livestock are raised and found the differences in WTP and buy, and satisfaction. Therefore, this study contributes to a better understanding of sustainable livestock.

The information about sustainable livestock production had a positive influence on participants' perceptions and their purchase behaviors. These results correspond with previous studies that show product information, such as brand names and ethical values, have an influence on consumers' liking and preference for a product (Napolitano et al., 2010; Sirieix et al., 2012; Vranešević and Stančec, 2003). Information influences consumers' intentions to purchase crucially (Bower et al., 2003; Kihlberg et al., 2005). Therefore, it is important to know what information based on livestock-rearing practices could affect consumers' purchase behaviors. In this study, among the three types of salami produced using sustainable practices, participants were willing to pay the most for animal welfare salamis when this information was revealed. This finding shows that consumers are willing to pay higher premiums for specific sustainable products. Moreover, the results indicate that purchasing behaviors for sustainable products are affected not only by ethical issues but also by the different cognitions of taste. Taste preferences can be affected by cognitive factors, such as information (Bower et al., 2003), so information can make the situation change so that the same taste is perceived in different ways. With the above in mind, this study offers practical information for understanding consumers' sensory evaluations and purchase behaviors. Thus, marketers and farmers can effectively use sustainable information publicly and employ it as one of the important marketing factors that may both satisfy consumers and sustain the welfare conditions of their animals.

A number of studies have examined food choices and preferences based on sensory attributes and extrinsic cues from an academic standpoint (Deliza and MacFie, 1996; Murray and Delahunty, 2000). However, very few studies have investigated sustainable livestock production from consumers' perspectives. This study examined whether or not consumers' sensory evaluations, including flavor, odor, and texture, and their purchase behavior change based on the information provided. The results confirmed that consumers' behaviors and responses in the informed condition changed their sensory evaluations, and the effects were different depending on the production method. The results of this study support Cardello's model that food is regarded as sensory stimulus and that consumers relate with various factors, including the information about the food, to create their food experiences (Cardello, 1994).

The present study has focused on understanding various aspects of sustainable livestock production by evaluating the differences in consumers' sensory evaluations, perceptions, and purchase behaviors depending on the presence or absence of information regarding livestock production methods. This implies that sustainability-related information can positively affect consumers' purchase behavior, and this is the first paper that has compared the results of sensory tests and purchase behaviors between present and absent information situations in terms of detailed classifications of sustainable livestock. This study is intended to be a useful source for further empirical research on sustainable livestock products.

While the results of this study provide a useful guideline for sustainable livestock marketers, it also has several limitations. First, this study only dealt with pigs raised in three types (antibiotic-free pigs, animal welfare pigs, and grazing pigs), but it seems that further research is needed on livestock raised in other sustainable ways and products other than salami to examine the sensory evaluation and purchasing behavior of consumers. Further studies are needed to include various kinds of livestock to understand these issues more deeply and to generalize the results. Second, to obtain more reliable and accurate research results, future studies should investigate the sustainable markets of other countries with participants from various sample groups. We only conducted surveys in Korea, so a sampling bias could be one error of this study. If future studies extend the methods presented here and include other populations, the results could be confirmed and extended further.

Conclusion

This study demonstrated the effects of sustainability-related information on consumers' sensory evaluations and purchase

behaviors. Despite evaluating the same products, there were some factors that made consumers feel differently based on sensory attributes under the absence and presence of information. This study confirmed that sensory evaluations are affected by external cues. Moreover, when sustainability information was provided to participants, their satisfaction and purchase intention increased in a positive way. In addition, the price premium of sustainable livestock varied positively with the types of information. In conclusion, this study investigated consumers' needs for sustainable livestock farming and provides meat producers and marketers with guidelines on how to effectively promote sustainable livestock to consumers.

Conflicts of Interest

The authors declare no potential conflicts of interest.

Author Contributions

Conceptualization: Hwang J, Jo M, Moon J. Data curation: Hwang J, Lee S, Jo M. Formal analysis: Hwang J, Moon J. Methodology: Hwang J, Cho W, Moon J. Software: Hwang J, Lee S, Jo M, Cho W. Validation: Hwang J, Lee S, Jo M, Cho W. Investigation: Hwang J, Lee S, Moon J. Writing - original draft: Hwang J, Lee S, Moon J. Writing – review & editing: Hwang J, Lee S, Jo M, Cho W, Moon J.

Ethics Approval

This manuscript was approved by the Seoul National University Institutional Review Board (IRB No. 1905/003-005).

References

- Ahn G, Song Y, Park K. 2014. Global trends and settlement of certification of animal welfare for livestock in South Korea (Overview). *Ann Anim Res Sci* 25:157-171.
- Aiking H, De Boer J, Vereijken J. 2006. Sustainable protein production and consumption: Pigs or peas? Springer Science & Business Media. Dordrecht, The Netherlands.
- Allen P, Van Dusen D, Lundy J, Gliessman S. 1991. Integrating social, environmental, and economic issues in sustainable agriculture. *Am J Altern Agric* 6:34-39.
- Annett LE, Muralidharan V, Boxall PC, Cash SB, Wismer WV. 2008. Influence of health and environmental information on hedonic evaluation of organic and conventional bread. *J Food Sci* 73:H50-H57.
- Anomaly J. 2015. What's wrong with factory farming? *Public Health Ethics* 8:246-254.
- Appleby MC, Mench JA, Hughes BO. 2004. Poultry behaviour and welfare. Cabi, Wallingford, UK.
- Bernués A, Ruiz R, Olaizola A, Villalba D, Casasús I. 2011. Sustainability of pasture-based livestock farming systems in the European mediterranean context: Synergies and trade-offs. *Livest Sci* 139:44-57.
- Bower JA, Saadat MA, Whitten C. 2003. Effect of liking, information and consumer characteristics on purchase intention and willingness to pay more for a fat spread with a proven health benefit. *Food Qual Prefer* 14:65-74.
- Burnier PC, Spers EE. 2019. Consumption occasion, choice and willingness to pay for sustainable attributes on beef. 16th SGBED & XII ESPM International Conference in Management, Sao Paulo, Brazil.

- Capper JL. 2013. Should we reject animal source foods to save the planet? A review of the sustainability of global livestock production. *S Afr J Anim Sci* 43:233-246.
- Cardello AV. 1994. Consumer expectations and their role in food acceptance. In *Measurement of food preferences*. Thomson DMH, MacFie HJH (ed). Springer. Boston, MA. pp. 253-297.
- Cardello AV, Maller O, Kapsalis JG, Segars RA, Sawyer FM, Murphy C, Moskowitz HR. 1982. Perception of texture by trained and consumer panelists. *J Food Sci* 47:1186-1197.
- Cenci-Goga BT, Ranucci D, Miraglia D, Cioffi A. 2008. Use of starter cultures of dairy origin in the production of salame nostrano, an Italian dry-cured sausage. *Meat Sci* 78:381-390.
- Chakraborty SK, Kumbhar BK, Chakraborty S, Yadav P. 2011. Influence of processing parameters on textural characteristics and overall acceptability of millet enriched biscuits using response surface methodology. *J Food Sci Technol* 48:167-174.
- Conner DS, Oppenheim D. 2008. Demand for pasture-raised livestock products in Michigan: Results of consumer surveys and experimental auctions. *J Food Distrib Res* 39:45-50.
- De-Magistris T, Gracia A. 2016. Consumers' willingness-to-pay for sustainable food products: The case of organically and locally grown almonds in Spain. *J Clean Prod* 118:97-104.
- Deliza R, Macfie HJ. 1996. The generation of sensory expectation by external cues and its effect on sensory perception and hedonic ratings: A review. *J Sens Stud* 11:103-128.
- Dodds WB, Monroe KB, Grewal D. 1991. Effects of price, brand, and store information on buyers' product evaluations. *J Mark Res* 28:307-319.
- Dransfield E, Ngapo TM, Nielsen NA, Bredahl L, Sjöden PO, Magnusson M, Campo MM, Nute GR. 2005. Consumer choice and suggested price for pork as influenced by its appearance, taste and information concerning country of origin and organic pig production. *Meat Sci* 69:61-70.
- Finch JE. 2006. The impact of personal consumption values and beliefs on organic food purchase behavior. *J Food Prod Mark* 11:63-76.
- Garcia E, Ramos Filho FSV, Mallmann GM, Fonseca F. 2017. Costs, benefits and challenges of sustainable livestock intensification in a major deforestation frontier in the Brazilian Amazon. *Sustainability* 9:158.
- Gomiero T, Pimentel D, Paoletti MG. 2011. Is there a need for a more sustainable agriculture? *Crit Rev Plant Sci* 30:6-23.
- Hellyer NE, Fraser I, Haddock-Fraser J. 2012. Food choice, health information and functional ingredients: An experimental auction employing bread. *Food Policy* 37:232-245.
- Hoek AC, Pearson D, James SW, Lawrence MA, Friel S. 2017. Healthy and environmentally sustainable food choices: Consumer responses to point-of-purchase actions. *Food Qual Prefer* 58:94-106.
- Horrigan L, Lawrence RS, Walker P. 2002. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environ Health Perspect* 110:445-456.
- Hwang SH, Hong JH. 2013. Sensory drivers of goso flavor in soymilk: Understanding a complex traditional Korean sensory attribute. *Food Qual Prefer* 29:113-125.
- Ingenbleek PTM, Immink VM, Spoolder HAM, Bokma MH, Keeling LJ. 2012. Eu animal welfare policy: Developing a comprehensive policy framework. *Food Policy* 37:690-699.
- Jinjarak S, Olabi A, Jiménez-Flores R, Walker JH. 2006. Sensory, functional, and analytical comparisons of whey butter with other butters. *J Dairy Sci* 89:2428-2440.
- Juhl HJ, Kristensen K, Østergaard P. 2002. Customer satisfaction in European food retailing. *J Retail Consum Serv* 9:327-

334.

- Kaaki D, Baghdadi OK, Najm NE, Olabi A. 2012. Preference mapping of commercial Labneh (strained yogurt) products in the Lebanese market. *J Dairy Sci* 95:521-532.
- Kaufmann T. 2015. Sustainable livestock production: Low emission farm—the innovative combination of nutrient, emission and waste management with special emphasis on Chinese pig production. *Anim Nutr* 1:104-112.
- Kihlberg I, Johansson L, Langsrud Ø, Risvik E. 2005. Effects of information on liking of bread. *Food Qual Prefer* 16:25-35.
- Kim JN, Kim TK, Chae HB, Kim SS, Park YS, Kim SJ. 2013. Consumer benefits of labels and bans for animal welfare. *Korean J Agric Manag Policy* 40:547-565.
- Kumar P, Chatli M, Mehta N, Singh P, Malav OP, Verma AK. 2017. Meat analogues: Health promising sustainable meat substitutes. *Crit Rev Food Sci Nutr* 57:923-932.
- Lebacqz T, Baret PV, Stilmant D. 2013. Sustainability indicators for livestock farming. A review. *Agron Sustain Dev* 33:311-327.
- Lyon BG. 1980. Sensory profiling of canned boned chicken: Sensory evaluation procedures and data analysis. *J Food Sci* 45:1341-1346.
- Marangoni C, de Moura NF. 2011. Sensory profile of Italian salami with coriander (*Coriandrum sativum* L.) essential oil. *Food Sci Technol* 31:119-123.
- Maughan C, Tansawat R, Cornforth D, Ward R, Martini S. 2012. Development of a beef flavor lexicon and its application to compare the flavor profile and consumer acceptance of rib steaks from grass-or grain-fed cattle. *Meat Sci* 90:116-121.
- Mench JA. 2008. Farm animal welfare in the USA: Farming practices, research, education, regulation, and assurance programs. *Appl Anim Behav Sci* 113:298-312.
- Mohr M, Schlich M. 2015. Socio-demographic basic factors of German customers as predictors for sustainable consumerism regarding foodstuffs and meat products. *Int J Consum Stud* 40:158-167.
- Moloney AP, Mooney MT, Troy DJ, Keane MG. 2011. Finishing cattle at pasture at 30 months of age or indoors at 25 months of age: Effects on selected carcass and meat quality characteristics. *Livest Sci* 141:17-23.
- Mudgil D, Barak S, Khatkar BS. 2017. Cookie texture, spread ratio and sensory acceptability of cookies as a function of soluble dietary fiber, baking time and different water levels. *LWT-Food Sci Technol* 80:537-542.
- Murray JM, Delahunty CM. 2000. Mapping consumer preference for the sensory and packaging attributes of Cheddar cheese. *Food Qual Prefer* 11:419-435.
- Napolitano F, Braghieri A, Piasentier E, Favotto S, Naspetti S, Zanoli R. 2010. Effect of information about organic production on beef liking and consumer willingness to pay. *Food Qual Prefer* 21:207-212.
- Pluhar EB. 2010. Meat and morality: Alternatives to factory farming. *J Agric Environ Ethics* 23:455-468.
- Pohjanheimo T, Sandell M. 2009. Explaining the liking for drinking yoghurt: The role of sensory quality, food choice motives, health concern and product information. *Int Dairy J* 19:459-466.
- Pretty JN. 1995. Participatory learning for sustainable agriculture. *World Dev* 23:1247-1263.
- Prickett RW. 2008. Consumer preferences for farm animal welfare: Results from a telephone survey of U.S households. MS Thesis, Oklahoma State University, Stillwater, OK, USA.
- Ritthiruangdej P, Suwonsichon T. 2006. Sensory properties of Thai fish sauces and their categorization. *Agric Nat Res* 40:181-191.
- Sánchez-Molinero F, Arnau J. 2010. Processing of dry-cured ham in a reduced-oxygen atmosphere: Effects on sensory

traits. *Meat Sci* 85:420-427.

- Schnettler BM, Vidal RM, Silva RF, Vallejos LC, Sepúlveda NB. 2008. Consumer perception of animal welfare and livestock production in the Araucania region, Chile. *Chil J Agric Res* 68:80-93.
- Siegrist M, Visschers VHM, Hartmann C. 2015. Factors influencing changes in sustainability perception of various food behaviors: Results of a longitudinal study. *Food Qual Prefer* 46:33-39.
- Sirieix L, Delanchy M, Remaud H, Zepeda L, Gurviez P. 2012. Consumers' perceptions of individual and combined sustainable food labels: A UK pilot investigation. *Int J Consum Stud* 37:143-151.
- Stampa E, Schipmann-Schwarze C, Hamm U. 2020. Consumer perceptions, preferences, and behavior regarding pasture-raised livestock products: A review. *Food Qual Prefer* 82:103872.
- Thompson PB, Nardone A. 1999. Sustainable livestock production: Methodological and ethical challenges. *Livest Prod Sci* 61:111-119.
- Verbeke W, Van Oeckel MJ, Warnants N, Viaene J, Boucqué CV. 1999. Consumer perception, facts and possibilities to improve acceptability of health and sensory characteristics of pork. *Meat Sci* 53:77-99.
- Vranešević T, Stančec R. 2003. The effect of the brand on perceived quality of food products. *Br Food J* 105:811-825.
- Webster AJF. 1994. Meat and right: The ethical dilemma. *Proc Nutr Soc* 53:263-270.
- Williams NM. 2008. Affected ignorance and animal suffering: Why our failure to debate factory farming puts us at moral risk. *J Agric Environ Ethics* 21:371-384.
- Yunlong C, Smit B. 1994. Sustainability in agriculture: A general review. *Agric Ecosyst Environ* 49:299-307.