

Consumer preferences and sensory characteristics of eggs from family farms

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ABSTRACT The objective of this study was to evaluate consumer habits as well as the sensory perception and characteristics of farm eggs produced in Los Ríos, Chile. Data were collected from an online survey of 197 respondents and a sensory evaluation carried out by 30 untrained panelists of 4 types of eggs (brown-shell and blue-shell eggs acquired from family farms, free-range eggs acquired from large, industrial systems, and white-shell cage eggs from industrial, cage systems.) To evaluate differences and preferences, data were analyzed in a GLM. In addition, sensory evaluation was analyzed using principal component analysis. In accordance with the survey, 99% of the participants eat eggs ($P < 0.001$), 58% eat 1 to 3 eggs/wk, and 84% declared to consume eggs at home (<0.0001). Surveyed participants reported that price and size are the determining factors (31%) when

purchasing eggs. Among the physical characteristic for consumers, yolk color was the most important attribute rather than white color, egg appearance, texture, flavor, or odor. In the consumer acceptability test, farm eggs (either brown or blue shell) received the most favorable sensory evaluation by the panel and were preferred to both free-range and white-shell cage eggs. Yolk color was the most influential parameter in making this difference. Brown farm eggs were predominately selected for greatest general satisfaction by participants in both the sensory evaluation ($P = 0.008$) and in the survey (40%; $P = 0.026$). There were no differences between farm eggs (brown and blue shell, $P > 0.05$) in the evaluated parameters. There was a consequence in the information given from surveyed consumers and the sensory panel with the yolk color.

Key words: farm egg, family farming, consumer egg preference, egg sensory characteristic

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INTRODUCTION

Consumer preferences for eggs have changed during the past decade, and their willingness to pay for cage-free eggs have led to increased research in this area (Norwood and Lusk, 2011; Lusk, 2019). This consumer trend has led to radical changes in the retail sector; in 2016, Walmart, the largest food retailer in the United States, announced plans to completely transition to cage-free eggs by the yr 2025. Walmart's decision to go cage free coincided with similar pledges by other large retailers and restaurants, such as Kroger and McDonalds

(Lusk, 2019). Consumer surveys show that animal welfare issues actually have more weight than environmental concerns (Heng et al., 2013), and some research showed that there is a demand for more natural, animal-friendly egg production systems (Texeira et al., 2018).

In general, consumers prefer eggs because they are safe to eat, easy to prepare, versatile, and cheap compared with other sources of animal protein (Martinez-Michel et al., 2011). However, habits and preferences for specific egg characteristics, such as shell color and egg size, differ between countries and between consumers within a country. While white-shell eggs are preferred in Japan, North and Central America, Middle East, India, Taiwan, and Philippines, brown-shell eggs are desired in much of Latin America, Europe, and China (Preisinger, 2018). Information from consumers from developing countries, such as Chile, is still scarce. Such information is greatly important owing to the incipient internal market for these

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eggs (i.e., free-range [**FR**] eggs) and the expected increases in production (Patterson et al., 2001).

Laying hen production systems can vary from conventional (cages) to alternative (barn, free range, organic, and so on) and differ in productive parameters, hens welfare (Sosnowka-Czajka et al., 20120), as well as in egg quality and nutritional composition (Rakonjac et al., 2014). In Chile, the egg industry showed that 98.2% of the commercial eggs sold at the market are produced in cages, while 1.2% are cage-free; 75% of eggs are of white shell, whereas 25% are of brown shell (Aguirre and Pizarro, 2018). Both industrial systems use commercial hybrids selected for a high-performance egg production. In contrast, in some rural areas, family farms produce eggs with local adapted indigenous hens. Often, the eggs are for self-sustainability; however, during the long-day season, a surplus is produced and sold at fairgrounds or small markets, among other means. These indigenous chickens are often double-purpose hens fed with pasture, insects, kitchen leftovers, and a complement of grains, such as wheat and maize (FAO, 2013). Moreover, many Chilean indigenous chickens have introgressed the oocyan gene for blue/green eggshell color from the Mapuche fowl, so both brown and blue eggs are the most frequent among peasant households (Alcalde, 2015).

Consumers often believe that eggs from family farms are more flavorful and have a better texture and better color than those obtained from industrial poultry farms. In addition, there is an important interest for consuming eggs from a more natural raising system using native breeds (Lordelo et al., 2017). However, no research has been conducted to confirm these assumptions. Therefore, the objective of this study was to evaluate consumption habits and sensory characteristics of eggs from family farms in the Los Rios region of Chile. The main hypothesis was that consumers will prefer eggs from family farms over those produced in industrial production systems.

MATERIALS AND METHODS

The study was carried out at the Institute of Animal Production of the Faculty of Agricultural Sciences of the Universidad Austral de Chile (Campus Isla Teja). In this study, family farms were those with family ownership of the land and the use of family labor. Here, ownership refers to both decision-making power and physical ownership of farm assets (e.g., land, housing, machines, and livestock), which allows the farm to be inherited by the next generation (van Vliet et al., 2015). In accordance with Chilean regulations (SAG, 2016), a family farm focused on poultry production is defined as “owner of poultry for the purpose of personal consumption or local sale with fewer than 500 birds.” It is important to note that in Chile farm, eggs are obtained from cage-free birds, mainly backyard systems.

Survey on Egg Consumption Habits

Consumption habits and perception of industrial and farm eggs produced in the Los Ríos region were evaluated

through a survey. This was developed on a Web page (e-encuesta.com) and made available online during May 2018. There were 23 questions with prefixed answers, divided into 3 sections: consumption, purchase, and knowledge and perception. The following sociodemographic information about the persons interviewed was recorded: age, gender, and area/region of residence. The survey had an initial question asking if respondents lived in the Los Ríos region to survey and analyze only data from consumers from that area. The questions used consumer-friendly language to ensure accurate answers. The questions used for this study were adapted from similar surveys on Chilean consumers of animal products (Vargas-Bello-Pérez et al., 2014, 2018, 2020).

Before using the final questionnaire, a pilot interview was performed face-to-face on 20 persons and then corrected for certain mistakes or doubts commented from voluntary individuals, to ensure clarity, accuracy of response options, use of scientific terminology, and the overall flow of the questionnaire. The questions sought to collect data on areas including the frequency with which eggs are consumed, what type of eggs survey respondents prefer and consume, and whether there is knowledge about the egg production system of FR hens. The information provided was confidential, as it was an anonymous survey that did not include personal identifiable information such as name or mailing address. Respondents were included in the analysis if they were 18 yr or older. The survey was answered online by 197 respondents, and the data were consolidated in a Microsoft Excel spreadsheet for analysis.

Sensory Panel

Four types of eggs were evaluated: brown-shell (**BrF**) and blue-shell (**BIF**) eggs (both from local family farms from the Los Ríos region), FR eggs produced in industrial systems, and white-shell cage (**WC**) eggs from industrial systems. Free-range and WC eggs were purchased at a local supermarket and were fresh with no more than 1 wk of packaging. A total of 15 eggs of each class were obtained for the panel sensory analysis.

Eggs for sensory analysis were hard-boiled, cooled, by placing eggs in water, heating the water to 100°C, and cooking for 8.5 min from the start of boiling. Then, the pot was removed from the stove, and the hot water was discarded and replaced with cool water at room temperature in which the eggs rested for 3 min. The eggs were peeled, cut into quarters and placed on plastic plates. Each treatment (class of egg) was randomly identified with a sample number (Hayat et al., 2010).

The panel consisted of thirty untrained judges. Before the sensory analysis, panelists were asked to not consume any food or smoke cigarettes for 3 h before the testing. Eggs from different production systems were evaluated through affective tests. To avoid response bias by eggshell colors, the panelist did not have access or visual contact with eggshells. Parameters evaluated were appearance, yolk color, white color, general aroma, general flavor, and texture (Hayat et al., 2010). The panelists evaluated

Table 1. Characteristics of survey respondents (n = 197) in Chile.

Characteristics	<i>p</i> ¹	LSM ²	SE	<i>P</i> -value (Pr > ChiSq)
Gender				0.0034
Female	0.57 (113/197)	0.297 ^a	0.144	
Male	0.43 (84/197)	-0.297 ^b	0.144	
Area of Residence				<0.0001
Urban zone	0.81 (160/197)	1.464 ^b	0.182	
Rural zone	0.19 (37/197)	-1.464 ^a	0.182	
Age (yr)				<0.0001
<20	0.005 (1/197)	-5.278 ^d	1.00	
21-40	0.568 (112/197)	0.276 ^a	0.14	
41-65	0.390 (77/197)	-0.444 ^b	0.15	
>65	0.036 (7/197)	-3.301 ^{c,d}	0.38	
Do you eat eggs?				<0.001
Yes	0.995 (196/197)	5.278 ^a	1.00	
No	0.005 (1/197)	-5.278 ^b	1.00	
How many eggs do you usually eat per wk (eggs/wk)?				<0.0001
1-3	0.584 (115/197)	0.338 ^a	0.145	
4-7	0.325 (64/197)	-0.732 ^b	0.152	
> more than 7	0.086 (17/197)	-2.359 ^c	0.254	
None	0.005 (1/197)	-5.278 ^d	1.003	
Place of consumption				<0.0001
Home	0.837 (195/233)	1.635 ^a	0.177	
Other than home ³	0.158 (37/233)	-1.667 ^b	0.179	
I do not eat eggs	0.004 (1/233)	-5.447 ^c	1.002	

Restaurants, work, school/university, and so on.

Different letters for answers to the same question indicate significant differences (*P* ≤ 0.05).

¹Proportion of survey respondents.

²Least square means in logit values.

³Restaurants, work, school/university, etc.

the eggs on a continuous unstructured line intensity scale (Karlsruhe scale) ranging from 0 to 9 (none to very-high intensity) and anchored at both ends with extremes for each attribute.

Statistical Analysis

For the survey, data were analyzed as binary and discrete dependent variables and were expressed as proportions. Data were analyzed with the GENMOD procedure of SAS (version 9.4; SAS Inst. Inc., Cary, NC) with the DIST = BIN and LINK = LOGIT defining a binomial distribution and a logit model:

$$n_i = \log [p_i / (1 - p_i)] = m + \tau_i,$$

where *p* corresponds to the probability of success, *m* is the overall mean of the proportion on the logarithmic scale, and τ_i the effect of group *i*.

Scores given by survey respondents for egg characteristics were analyzed with the MIXED procedure of SAS to determine the fixed effect of egg characteristic on consumers score. For sensory analysis, data were analyzed with the MIXED procedure of SAS to determine the fixed effect of egg production system and random effect of panelist with the LSMEANS statement to report least square means and SEM. As consumer preferences and sensory analyses are categorical data, the GENMOD procedure of SAS was run to verify the MIXED procedure results and obtain the odd ratios, which show the probabilities of contrasts (Uysal-Pala et al., 2006). The DIST = MULTINOMIAL and LINK = CUMCLL functions were included to define a multinomial distribution and a cumulative complementary log-log model. When

significant (*P* < 0.05), the DIFF command was used for pairwise comparisons.

Finally, a principal component analysis was performed for the following variables: appearance, yolk color, white color, general odor, flavor, and texture. The analysis was performed in Minitab (version 18, Minitab, LLC, State College, PA) based on the correlation matrix. The correlations were estimated by using the REML method. Statistical significance was declared with *P* ≤ 0.05.

RESULTS

Characteristics and Purchasing Behavior of Survey Respondents

A total of 197 persons were surveyed to characterize aspects related to the purchase, perception, and consumption of eggs, particularly those produced by local family farms. Consumer characteristics are described in Table 1. Only 1% of the surveyed population declared not to consume eggs. Women represented the highest proportion (57%; *P* = 0.0034) of total respondents. The age of respondents was grouped into 4 categories, the largest group comprising the age range between 21 and 40 yr (57%; *P* < 0.001). Ninety-nine percent claimed to consume eggs; the 1% that did not explain was for health problems. Fifty-eight percent of respondents answered that they consume 1 to 3 eggs a wk, most often at home.

Table 2 shows the type of eggs that consumers prefer to buy. Most respondents prefer to consume farm eggs rather than industrial eggs (white-shell eggs). Price and size were reported as the most important factors considered at the moment of purchase. The majority

Table 2. Egg purchasing behavior in Chilean consumers (n = 197) in Los Ríos, Chile.¹

Question/answer	<i>p</i> ¹	LSM ²	SE	<i>P</i> -value
What kind of eggs you buy?				<0,0001
Regular	0.811 (164/202) ^a	1.462	0.180	
Functional ²	0.144 (29/202) ^b	-1.786	0.201	
I do not buy eggs	0.045 (9/202) ^c	-3.066	0.341	
What type of eggs do you prefer to consume? (could mark more than one alternative)				<0,0001
White-shell	0.147 (47/320) ^c	-1.759	0.158	
Free-range or cage-free	0.165 (53/320) ^c	-1.617	0.150	
Brown-shell	0.288 (92/320) ^b	-0.908	0.124	
Farm eggs	0.394 (126/320) ^a	-0.432	0.114	
None	0.006 (2/320) ^d	-5.069	0.709	
Factors considered at moment of purchase				<0,0001
Shell color	0.218 (90/412) ^b	-1.275	0.119	
Size	0.317 (128/412) ^a	-0.797	0.107	
Price	0.317 (128/412) ^a	-0.797	0.107	
Nutritional attributes ³	0.061 (25/412) ^d	-2.239	0.206	
Shell quality	0.087 (36/412) ^c	-2.346	0.175	
I do not buy eggs	0.012 (5/412) ^e	-4.399	0.450	
How many eggs do you usually buy at a time?				<0,0001
30	0.388 (106/273) ^a	-0.455	0.124	
12	0.388 (107/273) ^a	-0.439	0.124	
10	0.022 (6/273) ^c	-3.796	0.413	
6	0.132 (36/273) ^b	-1.885	0.179	
1	0.044 (12/273) ^c	-3.079	0.295	
I do not buy eggs	0.022 (6/273) ^c	-3.796	0.413	
How much are you willing to pay for a dozen eggs?				<0,0001
CL\$1,500–\$2,000 (US\$1.76–US\$2.35)	0.456 (94/206) ^a	-0.175	0.139	
CL\$2,000–\$3,000 (US\$2.35–\$US3.52)	0.388 (80/206) ^a	-0.454	0.143	
> CL\$3,000 (>US\$3.52)	0.155 (32/206) ^b	-1.693	0.192	

Different letters for answers to the same question indicate significant differences ($P \leq 0.05$).

¹Proportion of survey respondents.

²Least square means in logit values.

³With some additive that may improve health (i.e., enriched with vitamin E, omega 3, antioxidants, and so on).

(78%) of respondents bought eggs in packs of 30 (39%) or 12 (39%), and 85% were willing to pay between CL\$1,500 and CL\$3,000 for a dozen eggs (US\$1.76 to US\$3.85), whereas just 15% were willing to pay more than CL\$3,000 (US\$2.35, $P < 0.0001$).

Consumer Knowledge and Perception of Cage-Free or FR Eggs

Fifty-two percent of respondents indicated that they were not familiar with cage-free or FR eggs, and 58% ($P < 0.001$) of respondents had never seen these types of eggs in supermarkets (Table 3). They also responded that although they were unfamiliar with FR egg production systems, 40% think they are different from farm eggs (Table 3). The respondents believe that there are differences between industrially produced eggs and farm eggs, and when asked what they believe these differences are, they said taste and color, followed by appearance. Thirty-eight percent ($P < 0.0001$) named the yolk as the part of the egg that is different between production systems (Table 3).

To determine consumer perception of the importance of egg components, respondents were asked to score egg characteristics between 1 (least important) and 4 (most important). Yolk color received a significantly greater ($P < 0.0001$) score than shell color, shell quality, and white quality (Table 4).

Sensory Evaluation

Table 5 shows the results of the sensory panel. No differences were found in consumer perception regarding the white color, general taste, and texture ($P > 0.05$) among the egg systems: industrial cage vs. the farm eggs. General odor scores tended to be higher for FR eggs than for the rest of the egg types.

Consumers tended to score the appearance of BrF eggs more favorably than WC eggs ($P = 0.0659$) for appearance. The color of the yolk presented higher values (more intense or redder; $P < 0.0001$) in the farm eggs (BrF and BIF) than the eggs from industrial production systems (FR and WC).

The BrF, BIF, and FR eggs were the most generally satisfying. However, in the preference test, only BrF eggs ($P = 0.025$) marked the highest vote with 40%. In addition, there were no differences for any parameter between the BIF and the BrF eggs.

The principal component analysis performed on the sensory variables (Figure 1) determined the presence of 2 main components, explaining 95% of the total variance. Principal component 1 in Figure 1 differentiated BIF and BrF eggs from industrial eggs (WC and FR) explaining 74.5% of the total variance, whereas principal component 2 explained 20.5%. Figure 1 explains that the characteristics of yolk color, texture, white color, appearance, and general taste have a positive influence

Table 3. Consumer knowledge of laying-hen production systems.¹

Item	<i>p</i> ¹	LSM ²	SE	<i>P</i> -value (Pr > ChiSq)
Have you ever seen cage-free or free-range eggs at the supermarket?				0.0009
Yes	0.416 (82/197) ^b	-0.338	0.145	
No	0.583 (115/197) ^a	0.388	0.145	
Are you familiar with the cage-free or free-range system?				0.4806
Yes	0.482 (95/197)	-0.071	0.142	
No	0.518 (102/197)	0.071	0.142	
Do you believe that eggs from cage-free or free-range systems are the same as farm eggs?				0.008
Yes	0.233 (46/197) ^b	-1.189	0.168	
No	0.401 (79/197) ^a	-0.401	0.145	
Do not know	0.365 (72/197) ^a	-0.552	0.148	
Do you believe that farm eggs are better (color, odor, flavor) than those from industrial/cage systems?				<0.0001
Yes	0.898 (177/197) ^a	2.180	0.236	
No	0.056 (11/197) ^b	-2.828	0.310	
Do not know	0.046 (9/197) ^b	-3.039	0.341	
Do you believe that farm eggs are different than those from industrial systems?				<0.0001
Yes	0.959 (189/197) ^a	3.162	0.361	
No	0.025 (5/197) ^b	-3.648	0.453	
Do not know	0.015 (3/197) ^b	-4.169	0.582	
Which differences have you perceived from farm vs. industrial eggs?				<0.0001
Odor	0.135 (73/540) ^c	-1.856	0.126	
Color (yolk and white)	0.276 (159/540) ^a	-0.965	0.096	
Taste	0.281 (152/540) ^a	-0.937	0.096	
Texture	0.116 (63/540) ^c	-2.024	0.134	
Appearance	0.179 (97/540) ^b	-1.519	0.112	
I do not perceive differences	0.011 (6/540) ^d	-4.489	0.411	
Which part of the egg do you think is different in farm eggs?				<0.0001
Shell	0.237 (65/274) ^b	-1.168	0.142	
Yolk	0.379 (104/274) ^a	-2.329	0.218	
White	0.083 (23/274) ^c	-0.491	0.125	
Overall	0.277 (76/274) ^b	-0.958	0.135	
I do not perceive differences	0.022 (6/274) ^d	-3.799	0.413	

Different letters for answers to the same question indicate significant differences ($P \leq 0.05$).

¹Proportion of survey respondents.

²Least Square means in logit values.

on principal component 1, whereas overall odor has a negative influence on principal component 2.

DISCUSSION

Characteristics and Purchasing Behavior of Survey Respondents

Of all individuals surveyed, the highest proportion was of women, which agrees with the study by Verbeke and Vackier (2004) and Vargas-Bello-Pérez et al. (2014, 2017). This indicates that women dominate the

Table 4. Scores given to different egg characteristics by the survey respondents.¹

Characteristic	Score ²	<i>P</i> -value
Yolk color	3.38 ± 0.91 ^a	
Shell color	2.65 ± 1.27 ^b	<0.0001
Shell quality	2.69 ± 1.33 ^b	
White quality	2.66 ± 1.20 ^b	

¹Different letters indicate significant differences ($P \leq 0.05$).

²4 = very important; 3 = important; 2 = less important; 1 = not important.

purchasing market compared with men, which was also true for meats purchased (Schnettler et al., 2009) and cheeses in Chile (Vargas-Bello-Pérez et al., 2017). The most frequent buyers are between the ages of 21 and 40 yr.

Ninety-nine percent of respondents consume eggs, and 1% answered that they do not consume them, mainly because of health reasons (food allergies, gastrointestinal discomfort, and so on). Pérez Canguero (2012) reported that 97.3% of respondents consume eggs and 2.7% did not do so for health reasons.

Fifty-eight percent of respondents reported consuming between 1 and 3 eggs per wk, which differs slightly from that reported by Guyonnet (2012), who indicated that in most countries, egg consumption per person is between 2 and 4 eggs per wk. The consumption of eggs per person has been increasing in recent yr in Chile from 199 in 2015 to 209 eggs/yr in 2017, and the expectation for 2019 is 230 eggs/yr *per capita*, and consequently, egg production has been increased (Aguirre and Pizarro, 2018).

Fearne and Lavelle (1996) reported that respondents prefer regular eggs to FR eggs owing to their lower price. This was also observed in the present study, where

Table 5. Means and SD of sensory variables¹ and preference² among different egg production systems.^{3,4}

Variables	BrF	BIF	FR	WC	<i>P</i> -value
Appearance	7.84 ± 0.9 ^x	7.36 ± 1.1 ^{x,y}	6.21 ± 1.8 ^{x,y}	6.00 ± 1.9 ^y	0.0659
Yolk color	8.02 ± 10.8 ^a	7.70 ± 1.28 ^a	6.03 ± 2.2 ^b	5.88 ± 1.7 ^b	<0.0001
White color	6.66 ± 1.5	6.68 ± 1.4	5.97 ± 1.5	6.33 ± 1.5	0.2458
General odor	6.51 ± 1.3 ^{x,y}	6.32 ± 1.3 ^{x,y}	6.6 ± 1.6 ^x	6.03 ± 1.3 ^y	0.0653
Flavor	7.19 ± 1.1	7.24 ± 1.2	6.94 ± 1.3	6.70 ± 1.4	0.8831
Texture	7.64 ± 0.9	7.0 ± 1.3	6.63 ± 1.5	6.72 ± 1.5	0.4587
Preference	-0.41 ± 0.37 (0.4) ^a	-0.69 ± 0.39 (0.33) ^{a,b}	-1.87 ± 0.54 (0.13) ^b	-1.87 ± 0.54 (0.13) ^b	0.0259

¹Hedonic scale from 1 to 9, where 1 means dislike extremely and 9 means like extremely.

²Preference was estimate as a coefficient (0 to 1) of how frequently the eggs were selected as the best by the panelists. Values are reported as Least Square means in logit values ± SEM and the probability value in ().

³Abbreviations: BIF, blue-shell farm egg; BrF, brown-shell farm egg; FR, free-range or cage-free eggs; WC, white-shell egg cage system.

⁴Letters a, b, and c in a variable indicate significant differences ($P \leq 0.05$), Letters x, y, and z indicate tendencies.

respondents preferred regular eggs mostly from family farms and industrial systems (brown eggs). It is important to note that as in many countries, in the Chilean supermarkets, FR eggs are the most expensive ones (CL \$3,000 to CL \$3,600 [US\$ 3.75 to US\$ 4.5]). Farm egg price is highly variable because of the seasonality of production. However, in some cases, if price is not a consideration, buyers prefer functional eggs and, in terms of color, prefer brown eggs (Hanis et al., 2013).

Our results show that price and size are the most important attributes for consumers when buying eggs. Mizumoto et al. (2008) and Fearne and Lavelle (1996) indicate that most people consider price, quality, and size. However, Vukasović (2014) and Walley et al. (2015) pointed out that the perceptions and purchasing factors in countries of the European Union are safety, welfare, environmental impact, freshness, taste, and local production, with different priorities depending on the country owing to differences in the purchasing power of the consumer.

It could be assumed that although most of the surveyed individuals say they prefer farm eggs, they indicated that they are only willing to pay between CL\$1,500 and CL\$2,000 (US\$1.76 to US\$2.35) for a dozen eggs, which does not match the market value for farm eggs, and this price range is within the industrial eggs value. As in Chile, Patterson et al. (2001) noted

that the eggs from different production systems (farm, FR, organic, and so on) have a higher price range than those produced in conventional, cage systems.

Consumer Knowledge and Perception of Cage-free or FR Eggs

Most respondents said they were unfamiliar with the FR egg production system and that they have never seen chicken eggs in supermarkets labeled in this way. Consumers believe that there are differences between industrially produced eggs and farm eggs. When asked which attribute causes those differences, most named the flavor and color (yolk and shell) and that the different part of the egg is the yolk, followed by the shell and the egg overall. Fearne and Lavelle (1996) indicate that respondents agreed that farm eggs have a better taste than eggs from industrial systems. Titcomb et al. (2019) found that the eggs present variations in the color of the yolk and that it is mainly due to the sources of pigmentation (natural or synthetic). Although the eggs are very similar nutritionally, their composition can be modified with a change in the diet of the hen (Nimalaratne and Wu, 2015).

The most important physical egg characteristic for the consumers surveyed was the yolk color, followed by the quality of the shell, white quality, and shell color. Based on a survey in several countries by the International Egg Commission, Guyonnet (2012) found that shell color preference is related to cultures and traditions as this varies from almost 100% white to 100% brown.

Sensory Evaluation

The panelists tended to score the appearance of the farm eggs more favorably than the eggs of industrial production systems. This contrasts with that reported by Hayat et al. (2010) and Schneider et al. (2013), who found that when comparing eggs from different production systems (conventional and organic), no significant differences were found in appearance and texture. The differences in appearance could be due to the reduction in the egg's internal quality over the storage period. Eggs in storage lose water and CO₂ through their shell, increasing the pH of the albumen, resulting in decreased

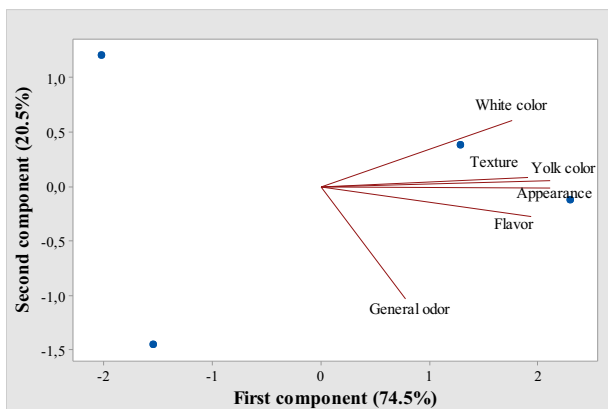


Figure 1. Principal components analysis of the sensory profile of the eggs, score graphic and projections graphic. Brown-shell (BrF) eggs, blue-shell (BIF) farm eggs, free-range or cage-free eggs (FR) and white-shell (WC) eggs from cage system.

freshness (Alleoni and Antunes, 2005). Another consideration will be that egg production systems have different bird genetics (Wan et al., 2019) and different dietary additives (Janist et al., 2019), which will influence the egg appearance.

Yolk color of farm eggs received a higher score than that of industrial eggs. This was likely owing to the fact that the industrial eggs have a pale yellow yolk, whereas the yolk of farm eggs is a more intense yellow with some orange tones (Titcomb et al., 2019). Variation in yolk color is due to the source of the pigmentation (natural or synthetic) and their levels of utilization and combinations between xanthophylls, stability and availability of xanthophylls, feed composition, stress, genetics, health status, as well as other factors. The content and profile of carotenoids and their absorption cause the color difference in the yolk. Van Den Brand et al. (2004) and Mugnai et al. (2009) reported that the yolks in farm eggs are darker because of access to foods rich in carotenoid pigments such as grasses. The general satisfaction and proof of preference suggest that consumers choose more farm eggs; therefore, it can be inferred that yolk color influenced consumer choice because the yolk has a higher market value (Fletcher et al., 1981). The principal component analysis confirms that panelist can detect differences between eggs, clearly grouping the industrial eggs separately from farm eggs.

CONCLUSIONS

The individuals surveyed preferred regular (nonenriched) and farm eggs and reported that price and egg size were the most important purchasing factors, whereas the yolk color was reported as the most important attribute. Interestingly, although respondents declared that they prefer eggs from farms or alternative production systems, they still choose to buy conventionally produced (cage) eggs because of the lower price. The sensory panel showed that brown- and blue-shell farm eggs were preferred over industrial eggs from FR and cage-free systems. In addition, the yolk color was the most important factor for the panelists when discriminating eggs from different production systems. There was a consistence in the information given from consumers and the sensory panel with the yolk color attribute.

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