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Consumer Preference and Quality Characteristics of Different-category Eggs Sold at Supermarkets in Rio de Janeiro

Preferência do Consumidor e Características de Qualidade em Ovos de Diferentes Categorias Comercializados nos Supermercados do Rio de Janeiro

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ABSTRACT

This study approached the consumer preference and characteristics of eggs from various categories sold at supermarkets in Rio de Janeiro. The study was performed in three phases. In the first one, 180 'caipira' eggs were randomly acquired from three supermarkets considering the consumers' socioeconomic profile (middle, upper, and lower class). In the second phase, 456 eggs from conventional, free-range, 'caipira' and omega-3 enriched categories were obtained without considering the socioeconomic condition. After the acquisition, the eggs were taken for further analyses made the next day. The last phase was based on the perception and prevalence of consumers found in the second stage. This time, 443 consumers answered a Google Forms questionnaire. 'Caipira' eggs sold at supermarkets frequented by upper-class consumers maintained a better quality. When social class was discarded as a criterion, eggs from 'caipira', free-range, organic, and omega-3 enriched systems showed inferior quality compared to conventional eggs. The consumer preferences indicated that much misinformation regarding technical aspects of egg production persists, despite the increasing consumption of this protein source. In addition, the study revealed that many consumers still think there are hormone inputs in poultry farming, and they know very little about the production process or the differences among the egg categories for sale at Brazilian supermarkets.
KEYWORDS: Consumption; Haugh unit; Shelf-time.

RESUMO

O estudo abordou a preferência de consumo e as características de qualidade em ovos de diversas categorias, comercializados em supermercados do Rio de Janeiro e foi realizado em três etapas. Na primeira, foram adquiridos de forma inteiramente casualizada, 180 ovos marrons apenas de categoria caipira, em três diferentes supermercados, considerando o perfil socioeconômico dos consumidores (classe média, baixa e alta). Na

segunda, foram adquiridos pelos mesmos critérios e de supermercados distintos, 456 ovos marrons de várias categorias (convencional, free-range, caipira, orgânicos e enriquecidos (ômega-3), sem considerar a condição socioeconômica dos consumidores. Após aquisição, foram levados para análise, que foi realizada no dia seguinte. A terceira etapa, se baseou na percepção e prevalência de consumo de ovos da mesma categoria da segunda etapa, em entrevista na forma de questionário disponibilizado na plataforma Google Forms, para um total de 443 participantes. Ovos de categoria caipira, comercializados em mercados frequentados por consumidores de classe alta, mantiveram melhor a qualidade. Quando não foi considerada a classe social, ovos free-range, caipira, orgânico e enriquecidos apresentaram qualidade inferior, comparado aos convencionais. A preferência de consumo abordada, indicou que o aumento no consumo de ovos, é acompanhado de muita desinformação acerca de vários aspectos inerentes a essa proteína e de forma alarmante, revelou que muitos consumidores ainda acreditam na participação de hormônios na produção de aves, além de pouco ou nada conhecerem sobre como esse alimento é produzido e as diferenças entre as diversas categorias de ovos expostos à venda nos supermercados brasileiros.
PALAVRAS-CHAVE: Consumidor; Tempo de prateleira; Unidade Haugh

INTRODUCTION

Chicken eggs have become very popular among Brazilian consumers because of their versatility, who consider this food a "joker" protein source, mainly in times of economic crisis and costly meat at supermarkets. In this context, there is an increase in egg consumption because it is a valuable animal protein source.

The world's criteria for acquiring eggs have changed in the last years, with the evident importance of bird welfare (Mazzuco, 2008) boosting the alternative-egg segment. Viewing this context, supermarket shelves have diverse egg types labeled as cage-free, free-range, and omega-3 enriched.

Conventional eggs are those produced by caged laying hens, and this type of system is predominant in Brazil. In the cage-free system, the birds were reared at low densities in sheds, and the laying occurs in nests. The free-range system differed from the cage-free by birds accessing an external area (paddocks). Both systems provide a welfare condition, but they increase production costs. The organic system for producing eggs is conducted in free-range areas but with obligations of specific feeding management, which also increases the costs. Moreover, the 'caipira' system is characterized by a traditional way to rear the laying hens under a free-range approach. As well as the other alternative systems, 'caipira' eggs often are more expensive than conventional ones. Enriched eggs, also known as PUFA eggs, have more polyunsaturated fatty acids, becoming a food alternative with high nutritional value and low cost compared to other sources of omega-3, such as salmon and tuna fishes (Mazalli, 2019).

Regardless of the egg type the consumers buy, poultry farms and supermarkets must guarantee egg quality as a product. Eggs laid by healthy and well-fed birds must be sent to the market with excellent quality, which may be reduced under improper conditions (e.g., without refrigeration). Unsuitable conditions can accelerate quality losses (Amaral et al., 2016). Thus, considering the high prices of 'alternative' eggs, they may remain on shelves for more time, compromising the maintenance of their inner quality.

Based on this context, this study approached the consumer preference and the quality characteristics of eggs from diverse categories sold at supermarkets in Rio de Janeiro (conventional, enriched, free-range, organic, and 'caipira').

MATERIAL AND METHODS

The study was performed in three phases using different-category eggs (conventional, 'caipira,' free-range, organic, and omega-3 enriched) for sale at supermarkets in Rio de Janeiro.

In the first phase, only 'caipira' eggs were assessed, and three commercially relevant supermarkets in Rio de Janeiro were chosen for the study in September 2020. One hundred eighty brown eggs classified as big were acquired from different brands. They were conditioned into acetate packaging containing ten eggs each. These eggs were randomly chosen by simulating an ordinary consumer.

The three supermarkets had air-conditioning systems, and they were selected regarding the socioeconomic profile of the potential consumers (upper, middle, and low classes). Thus, the letters A, B, and C identified the stores regarding the classes (upper, middle, and low, respectively). Only in store B were the eggs conditioned near cooled shelves.

After the acquisition, eggs were transported to the Meat and Carcass Laboratory of Animal Science Institute from UFRRJ, where they remained on a proper bench. The eggs were analyzed regarding their physical-chemical traits on the next day. The Haugh unit (HU) was determined using the equation: HU = 100log (H + 7.57 – 1.7W0.37) (HAUGH, 1937, modified by EISEN et al., 1962). The yolk index (YI) was calculated by dividing the yolk height by the diameter. The yolks were separated from the albumen and eggshell to determine the proportions of egg components (albumen, yolk, and eggshell) using a digital scale with 0.01-g precision. The albumen weight was calculated by subtracting the total egg weight from those of the yolk and eggshell. The yolk color was assessed using a colorimetric fan (Roche®), whose intensity varies from light yellow to orange on a scale from 1 (pale yellow) to 15 (intense orange). Yolk and albumen were separated and posterior homogenized to form a pool, according to the method described by Rocha et al. (2013). After that, the pH was measured with a pH meter. The eggshells were washed with running water and dried at 105° C for two hours in an oven. After that, the eggshells were weighed and measured regarding their thicknesses, assessed in two fragments from the equatorial region using a digital pressure micrometer (Mitutoyo® brand, model PK-0505CPX). The specific gravity (SG) was determined using the Hamilton method (HAMILTON, 1962) through the following densities: 1.060, 1.065, 1.070, 1.075, 1.080, 1.085, 1.090, 1.095, and 1.100.

In the second phase, also realized at Rio de Janeiro, 456 eggs were obtained using the same criteria of the first phase, but this time from distinct supermarkets and without considering the socioeconomic profile. This phase lasted four months, occurring from March to July 2021. The eggs from different categories (conventional, 'caipira,' free-range, organic, and omega-3 enriched) were available for sale and stored into recycle cardboard packaging. All the physical-chemical analyses performed in the first phase were repeated in this second one.

Data were submitted for analysis of variance using the SISVAR® software,

and the effects of the treatments were submitted to Tukey's test at a 5% of error probability in the means comparisons.

The last phase was based on the perception and prevalence of consumers regarding the studied egg categories. This time, a Google Forms questionnaire comprising 14 objective questions was delivered and answered by 443 consumers with varied scholarship degrees. The consumers' profile was evaluated from statistical analyses generated in the platform from the collected data. Thus, information about the scholarship degree, the criterion used in the purchase time, the prevalence of egg category, weekly frequency consumption, plus the purchase and storage locations were obtained from the questionnaire.

RESULTS AND DISCUSSION

The results of the first study phase, in which only the 'caipira' category was assessed, and the socioeconomic condition was accounted for, are displayed in Table 1.

Table 1- Physical-chemical quality parameters of 'caipira' eggs for sale at supermarkets in Rio de Janeiro.

	Supermarkets				
Assessed parameters	A	B	C	P-value	CV (%)
Egg weight (g)	59.34b	63.80a	59.86b	<0.001	7.11
Eggshell percentage (%)	10.06	10.00	9.83	0.132	6.54
Eggshell thickness (mm)	0.430a	0.432a	0.408b	<0.001	5.56
SG	1.086b	1.089a	1.080c	<0.001	0.52
Yolk color	8.81 c	10.81 b	11.37a	<0.001	9.61
Yolk index	0.41 a	0.36 b	0.32 c	<0.001	11.29
HU	70.92b	76.22a	66.77b	<0.001	15.22
Albumen pH	9.32 b	9.41a	9.38a	0.002	1.57
Yolk pH	6.67 a	6.34 c	6.51b	<0.001	4.12

Means followed by the same lowercase letters within rows do not differ by Tukey's test at 5% of probability of error; CV = coefficient of variation; SG = specific gravity; HU = Haugh unit; A = upper-class supermarket; B = middle-class supermarket; C = low-class supermarket.

The weights of 'caipira' eggs showed values according to those classified as 'extra' type for this category, corroborating the established pattern by the Brazilian legislation (MAPA, 2023).

Eggshell percentages did not differ because of the evaluated supermarkets (Table 1). The average eggshell thickness was relatively superior to 0.33 mm indicating excellent quality (LEMOS et al., 2015). The eggshell is often thicker in 'caipira' egg production systems of a greater calcium input owing to birds grazing, besides pecking and intake of small stones (OLIVEIRA et al., 2009).

Specific gravity (SG) values were adequate (Table 1). According to Silva (2004), eggs' SG must not exceed 1.080. In the present study, the lowest SG was found in supermarket C (low-class supermarket). Lower SG values are reported mainly by the prolonged egg storage time on shelves, negatively affecting density (SANTOS et al., 2009). The lesser purchase power of consumers

of supermarket C could have contributed to the 'caipira' eggs remaining more time on shelves in this store. According to Mendes et al. (2016), the consumers' preference for an egg category happens primarily because of the price at the bought moment.

The intensity of yolk pigmentation was on the expected patterns for eggs from ‘caipira’ category (Table 1), remaining from 9 to 14 in the Roche® colorimetric fan (NYS & GUYOT, 2011). Eggs sold in the supermarket A were the exception, and presented lower values than those observed in other stores, despite this supermarket is frequented by upper-class consumers, which could provide a high output of ‘caipira’ eggs. The high yolk pigmentation often occurs when birds have access to paddocks with a varied source of pigment feeds, such as grasses, seeds and shoots (VAN DEN BRAND et al., 2004). Another option is incorporating natural or synthetic pigments into the hens’ rations. Such strategy is commonly adopted since the yolk color is one of the most sensorial traits required by consumers, because they often relate the yolk pigmentation to the egg nutritional value (RADDATZ-MOTA et al., 2017). Also, the carotenoid oxidation by longer storage times may be intensified by higher temperatures, which may reduce the yolk pigmentation even more (CANER, 2005). In this sense, Sabino et al (2022) found reductions in the yolk pigmentation of ‘caipira’ eggs stores for 12 days at room temperature.

Regarding the yolk index, the lowest and non-standard values were observed in eggs sold in supermarkets B (middle class) and C (low class) (Table 1). According to Oliveira & Oliveira (2013), yolk index values lower than 0.39 represent compromised quality. Over time, water in the albumen migrates to the yolk, causing this structure to elongate and flatten, resulting in stretching and greater fragility of the vitelline membrane (SUCKEVERIS et al., 2015). Santos et al. (2011) found that ‘caipira’ eggs marketed in Rio Verde (Goiás) had a yolk index very close to the minimum quality limit, as well as Silva Filho et al. (2015) also found low yolk index values in 54.9% of ‘caipira’ eggs sold in the municipality of Seropédica (RJ). In popular markets, ‘caipira’ eggs tend to remain longer on shelves and are more expensive (VIEIRA et al., 2021).

The Haugh Unit (HU) presented values of intermediate quality in eggs sold by supermarkets A (upper class) and C (low class) but good values in supermarket B (middle class) (Table 1). The HU should be over 72 for good-quality eggs, while values between 60 and 72 represent intermediate quality, and values less than 60 mean poor quality (USDA, 2007). Low HU values and yolk index may occur depending on the period and storage conditions in which the eggs are submitted. During storage, albumen liquefaction occurs, which causes a reduction in its dense fraction, thus decreasing HU values (GIAMPIETRO-GANECO et al., 2015). Lordelo et al. (2017) described low values (61.1) in the HU in 'caipira' eggs sold in Portugal.

The albumen and yolk pH values were high in all supermarkets (Table 1). The albumen pH in fresh eggs varies from 7.7 to 9.9, rising according to the storage period (DOMINGUES & FARIAS, 2019). Water and carbon dioxide are lost as the egg ages, which raises the pH. Lordelo et al. (2017) observed high pH values (9.28) in ‘caipira’ eggs sold in Portugal. The authors suggest that the storage time determines albumen pH almost entirely. The yolk pH is usually around 6.0 but may achieve 6.9 owing to alkaline ions migration (sodium, potassium, and magnesium) from the albumen to the yolk over the storage

period (DOMINGUES & FARIAS, 2019). Saccomani et al. (2019) described yolks with a pH value of 6.35 in 'caipira' eggs stored for 28 days at room temperature. Arruda et al. (2019) verified yolks with pH 6.7 in 'caipira' eggs kept for 14 days at room temperature. It is essential to consider that alternative eggs, regardless of the category, reach consumers with high prices compared to conventional eggs. In addition, the amount of eggs in the packages is reduced because while conventional eggs are offered in boxes of 12 eggs, alternatives are available in packs of ten eggs. These two issues can contribute to the longer time of 'caipira' eggs on shelves, mainly in popular markets, which worsens the egg quality under improper temperature and humidity storage conditions.

The results referring to the second study phase, which evaluated the physical-chemical quality of conventional, omega-3 enriched, 'caipira', free-range and organic eggs sold in supermarkets other than the first stage, without considering the consumers' socioeconomic status, are shown in Table 2.

Table 2- Physical-chemical quality parameters of conventional, omega-3 enriched, and 'caipira', free-range and organic eggs for sale at supermarkets in Rio de Janeiro.

Assessed parameters	Egg type					P-value	CV (%)
	Conventional	Omega-3 enriched	'Caipira'	Free-range	Organic		
Egg weight (g)	60.45a	60.57a	58.20b	60.45a	58.84b	< 0.0001	5.68
Eggshell percentage (%)	9.98	10.04	10.21	10.01	10.14	0.5005	9.72
Eggshell thickness (mm)	0.43	0.42	0.43	0.42	0.43	0.1418	7.72
Yolk percentage (%)	29.02ab	28.02b	28.77ab	28.72ab	29.94a	0.0067	10.27
Albumen percentage (%)	61.38	61.97	61.46	62.27	60.44	0.2346	7.47
Yolk color	9b	11a	10a	9b	8b	< 0.0001	23.01
Yolk index	0.39a	0.35bc	0.33cd	0.37b	0.33d	< 0.0001	14.32
HU	78.04a	72.55b	68.37b	70.69b	71.11b	< 0.0001	18.37
Albumen pH	9.44	9.49	9.52	9.45	9.47	0.9648	1.88
Yolk pH	6.96	6.87	7.15	6.76	7.04	0.9531	10.6

Means followed by the same lowercase letters within rows do not differ by Tukey's test at 5% of probability of error; CV = coefficient of variation; HU = Haugh unit.

The highest egg weights were observed in the conventional, free-range, and enriched categories compared to the others. All evaluated categories presented egg-weight averages according to CIPOA resolution nº 5/91, where eggs weighing 55 to 60 g are considered Large Type (MAPA, 2005).

The eggshell percentage did not differ among the egg types evaluated (Table 2). Saccomani et al. (2019) reported similar results, without observing discrepancies in eggshell percentages of conventional, free-range, and cage-free systems kept at different temperatures for 28-day storage.

The eggshell thickness did not differ among categories (Table 2). Lemos et al. (2015) state that thickness values smaller than 0.33 mm indicate poor eggshell quality. Thus, the types analyzed showed an excellent qualitative index since all values were over 42 mm. The eggshell does not lose thickness during storage,

and when its thickness is suitable, as observed in the present results, it can help maintain the egg's inner quality.

Organic eggs had higher yolk percentages, followed by conventional, 'caipira', and free-range eggs (Table 2). Omega-3 enriched eggs showed a lower value for this index. Conversely, no significant differences were observed for albumen percentage regarding the egg types assessed.

'Caipira' and enriched categories showed the highest yolk color intensities (Table 2). The yolk color comes from the carotenoids absorbed when birds ingest pigmented feeds. Thus, birds reared in grazing systems, such as 'caipira', free-range and organic, tend to produce more pigmented eggs than those reared in conventional systems, owing to their access to assorted vegetables with high levels of xanthophylls (GALOBART et al., 2004; RIZZI & MARANGON, 2012). Omega-3-enriched egg yolks can present a solid orange color. According to Faitarone et al., 2016, it is owing to the higher absorption of carotenoids and xanthophylls in rations since these pigments are liposoluble, and their absorption is optimized when diets are rich in fatty acids. When evaluating eggs enriched with linseed oil, Takatani (2018) observed intensely colored yolks with an 11.13 average on the colorimetric fan scale.

'Caipira' and organic eggs showed the lowest values for yolk index (Table 2), implying compromised quality (OLIVEIRA & OLIVEIRA, 2013). The factors influencing this index are the same as the albumen quality. Thus, during storage, the egg quality is affected by the temperature at which this product is submitted, besides the humidity and time (GIAMPIETRO-GANECO et al., 2015; LANA et al., 2017).

The conventional category led to the best result for HU in eggs compared to the others (Table 2). The HU should be over 72 for good-quality eggs, while values between 60 and 72 represent intermediate quality, and values less than 60 mean poor quality (USDA, 2007). The HU is a quality parameter influenced by albumen liquefaction, a process that accelerates at room temperature (LANA et al., 2017). Conventional eggs' higher turnover probably happened due to their lower prices, which may have contributed to the HU results reported here.

Albumen and yolk pH values did not differ among categories (Table 2). However, the observed pH results are wildly distant from the preconized standard. The albumen pH in fresh eggs varies from 7.7 to 9.9, rising according to the storage period. Conversely, yolk pH is usually around 6.0 but may achieve 6.9 over storage time (DOMINGUES & FARIAS, 2019). The worst yolk pH result was observed in 'caipira' followed by organic eggs. Changes in albumen and yolk pH values are related to the biochemical changes during storage (BRANDÃO, 2014).

The last phase, which characterized the perception and prevalence of different-type egg consumption through research, indicated that the vast majority of respondents do not know the differences between egg production systems (cage-free, free-range, and 'caipira') (Figure 3), believing there are no nutritional contrasts between eggs with white and brown shells. Furthermore, the public unknowns the egg protein's nutritional qualities (Figure 4).

Regarding the consumers' preference by category (Figure 2), white eggs had the highest acquisition preference, followed by brown eggs. The egg price criterion was crucial for the public purchase decision, followed by those who selected the product based on the expiration date and those who preferred to purchase the

product based on the eggshell color (Figure 1).

Regarding the frequency of weekly consumption, only 40% of the interviewed consumers have the habit of consuming eggs from two to five times a week, followed by those who indicated consuming a maximum of twice a week. With a lower index, those who consume more than five times a week and 49.4% of respondents reported not knowing the recommendation of the World Health Organization (WHO) to eat at least one egg daily. Most prefer to buy eggs in supermarkets and store them for a week before consumption, majorly in refrigerators. The rest like to buy eggs in fairs and stow them at room temperature. Nevertheless, the result catching the most attention was that most interviewees still believed in hormones' presence in eggs (Figure 5).

The results of asked questions to consumers during the interview phase are shown in the following figures.

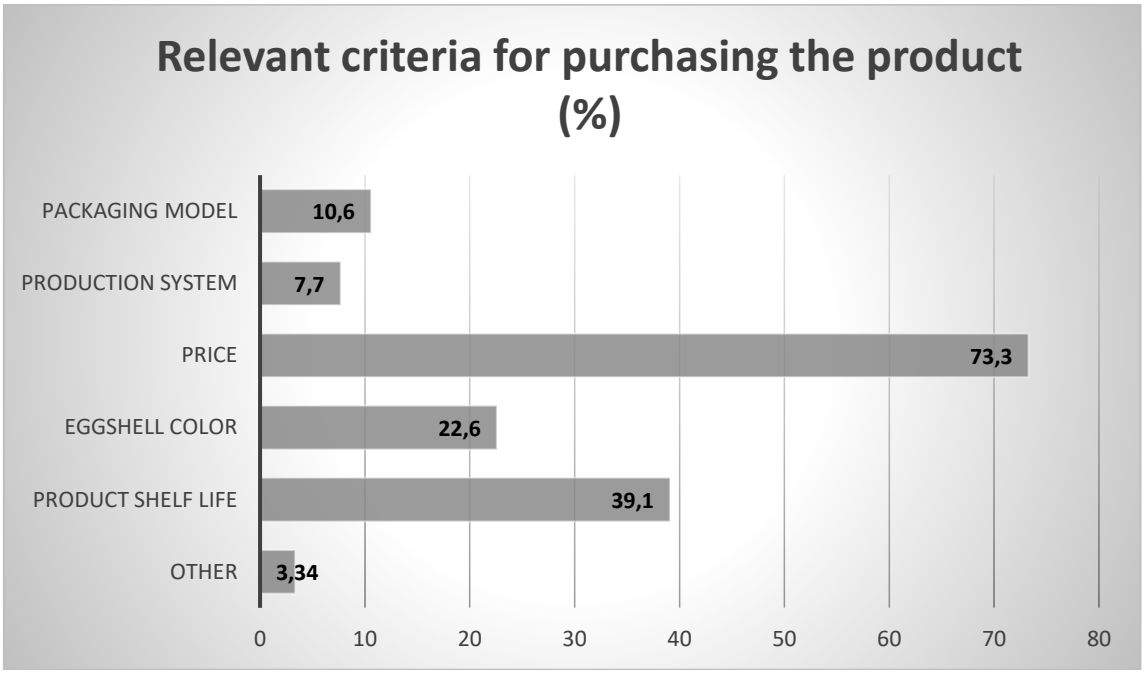

Figure 1- Percentage of relevant criteria for purchasing the product

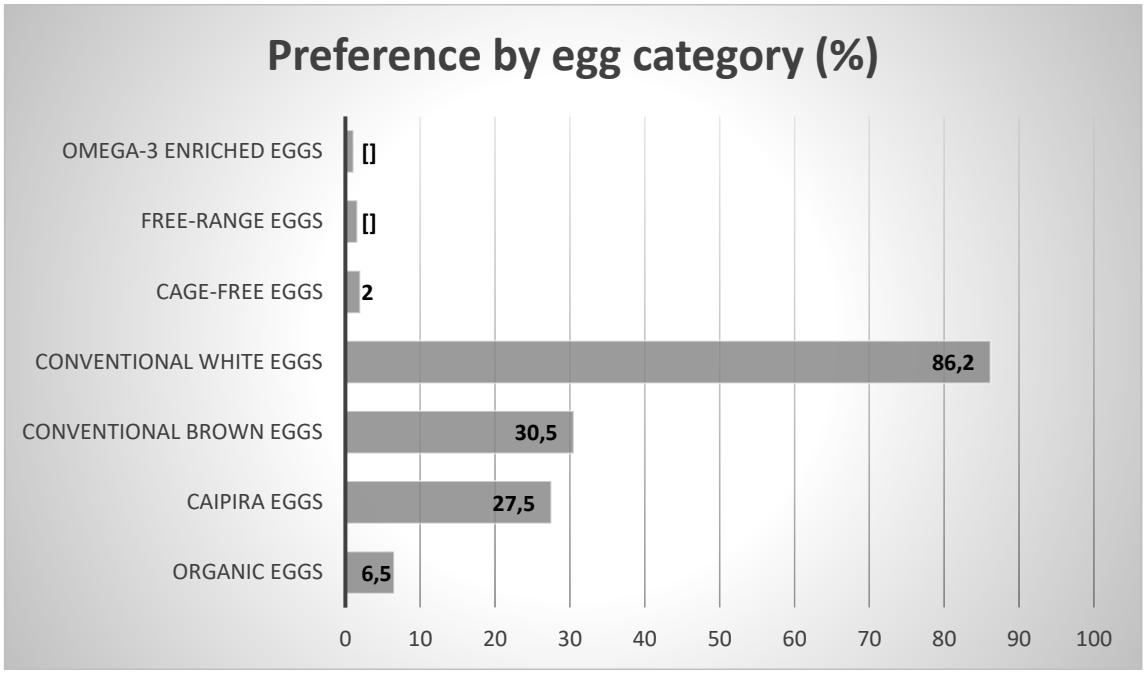

Figure 2 - Preference by egg category

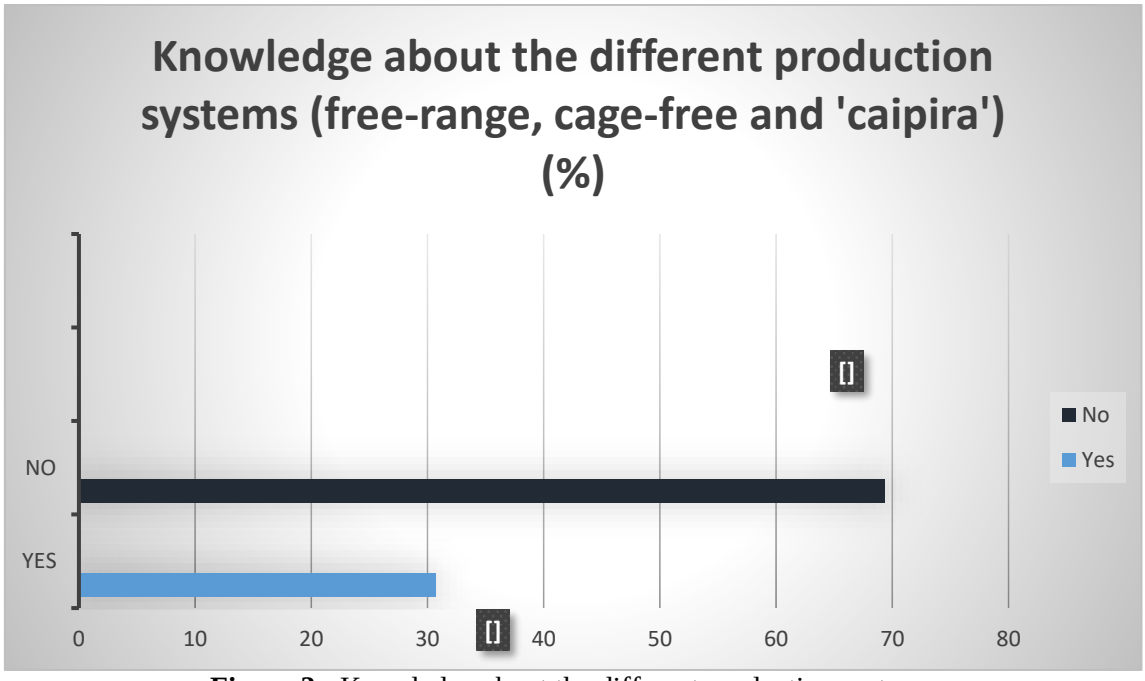

Figure 3 - Knowledge about the different production systems

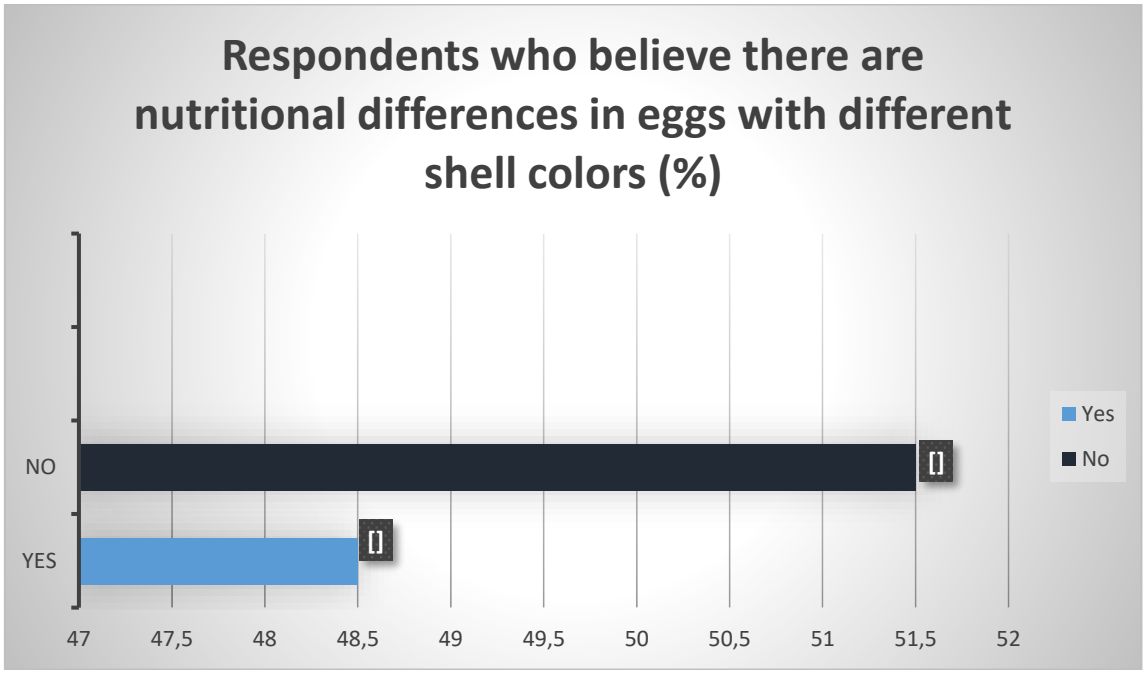

Figure 4 - Respondents who believe there are nutritional differences in eggs with different shell colors

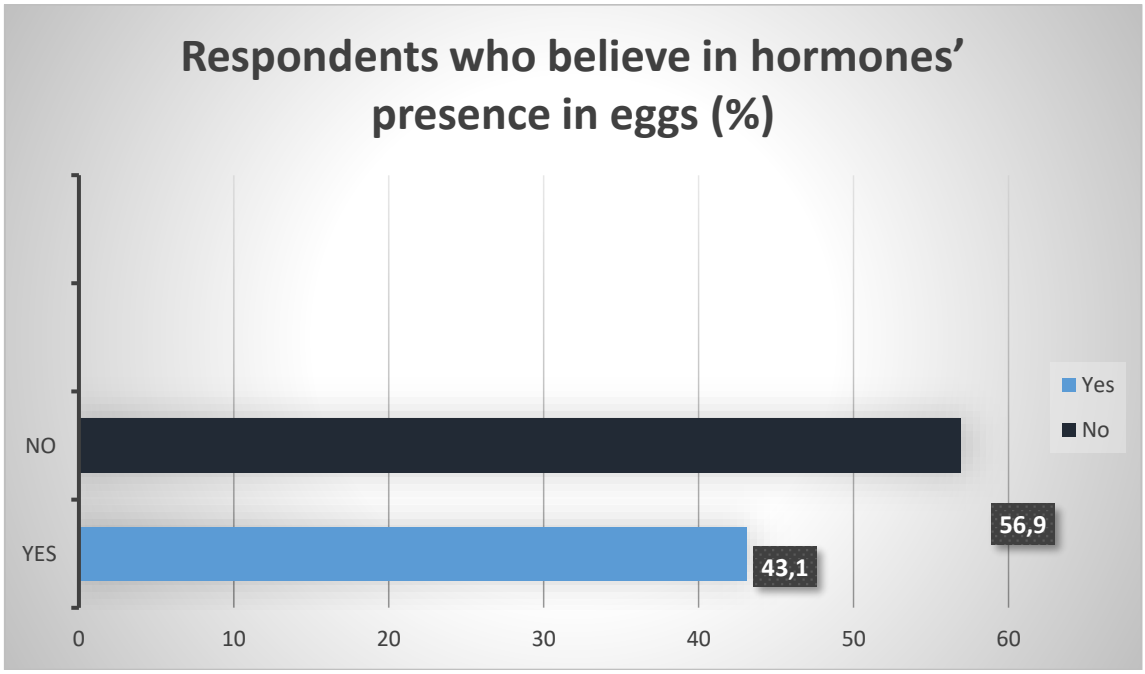

Figure 5- Respondents who believe in hormones' presence in eggs

CONCLUSION

The consumer preference and quality characteristics of eggs of different categories sold in supermarkets in Rio de Janeiro indicated that 'caipira' eggs stored in climatized markets frequented by high-class consumers maintained their inner quality better. Without considering the social class, alternative eggs ('caipira', free-range, organic, and omega-3 enriched) displayed lower indexes than conventional ones when

referring to the inner quality characteristics.
The consumers' prevalence and perception indicated that much misinformation regarding technical aspects of egg production persists, despite the increasing consumption of this protein source and, alarmingly, revealed that many consumers still believe in myths such as the hormones' participation in poultry farming. In addition, the public knows little about egg production and the differences between categories available for sale in Brazilian markets. It was concluded that more efforts should be employed to disseminate the benefits of egg consumption. Furthermore, refrigeration conditions must be adapted and standardized at points of sale, especially for alternative eggs, since they are more expensive and remain longer on shelves.

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