Brazilian egg industry - current situation, perspectives, and future challenges

Indústria brasileira do ovo - situação atual, perspectivas e desafios futuros

Industria brasileña del hueso - situación actual, perspectivas y desafíos futuros

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Abstract
The Brazilian egg industry has experienced a significant increase in production since the late 1990s, presenting growth rates above the world leaders in egg production and occupying a prominent position in this market, led by China and the US. This study aimed to evaluate the current egg market and the challenges ahead to achieve or even surpass the performance predicted in the time series analysis. Overall, securing the world's supply comes with challenges common to different egg producers. Thus, historical series analyses of production and exports of the Brazilian egg industry were carried out. It was found that Brazil had a total growth rate of 83.31%, higher than the Chinese growth (78.76%) in the same period, while the US production showed the lowest growth rate per year and total among those evaluated in this study. This production activity's future will be determined by different factors and the

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strategies chosen by producers to ensure a sustainable product supply. These strategies are based on the environmental performance of the production systems, food safety, and nutrient circularity by transforming production waste into value-added products.

**Keywords:** Commercial Laying. Egg Products. Exports. Production. Brazil.

**Resumo**
A indústria brasileira de ovos tem experimentado um aumento significativo na produção desde o final da década de 1990, apresentando taxas de crescimento acima dos líderes mundiais na produção de ovos e ocupando uma posição de destaque neste mercado, liderado pela China e os EUA. Este estudo teve como objetivo avaliar o mercado atual de ovos e os desafios futuros para alcançar ou mesmo superar o desempenho previsto na análise da série temporal. Em termos gerais, garantir o abastecimento mundial implica desafios comuns aos diferentes produtores de ovos. Assim, foram realizadas análises históricas em série da produção e das exportações da indústria brasileira de ovos. Constatou-se que o Brasil teve uma taxa de crescimento total de 83,31%, superior ao crescimento chinês (78,76%) no mesmo período, enquanto a produção norte-americana apresentou a menor taxa de crescimento por ano e total entre as avaliadas neste estudo. O futuro desta atividade produtiva será determinado por diferentes fatores e pelas estratégias escolhidas pelos produtores para garantir um abastecimento sustentável do produto. Essas estratégias são baseadas no desempenho ambiental dos sistemas de produção, segurança alimentar e circularidade de nutrientes, transformando resíduos de produção em produtos de valor agregado.


**Resumen**
La industria brasileña del huevo ha experimentado un aumento significativo en la producción desde finales de la década de 1990, presentando tasas de crecimiento por encima de los líderes mundiales en producción de huevos y ocupando una posición prominente en este mercado, liderado por China y Estados Unidos. Este estudio tuvo como objetivo evaluar el mercado actual del huevo y los desafíos que se asemejan para lograr o incluso superar el rendimiento previsto en el análisis de series de tiempo. En general, asegurar el suministro mundial conlleva desafíos comunes para los diferentes productores de huevos. Así, se realizaron análisis de series históricas de producción y exportaciones de la industria brasileña del huevo. Se encontró que Brasil tuvo una tasa de crecimiento total de 83,31%, superior al crecimiento chino (78,76%) en el mismo período, mientras que la producción estadounidense mostró la
Introduction

Commercial laying poultry (Brazilian egg industry) is intertwined with the Portuguese colonization and gained special impulse as a production chain in the 1920s with the Japanese colonization in the interior of the state of São Paulo. In the late 1990s, this production chain went through a transformation period through production intensification and automation, made possible by the country's opening to equipment and technology imports (sheds, egg graders, and others) (Pires & Pinto, 2020). This intensification increased productivity, which met the product's growing demand, both for the domestic market and to enable the product's export (Mazzuco, 2008). Regarding world production, China is currently the largest egg producer, while Brazil is among the ten largest producers (Figure 1).
The egg is an important source of animal protein, with 94% biological value. However, its consumption was limited between 1968 and 2015, when it was targeted for dietary restrictions, initially by the American Heart Association (McNamara, 2015). Such restrictions were only removed after studies proved its nutritional potential, besides being considered a functional or nutraceutical food (Marcia Vizzotto, Ana Cristina Krolow, 2010). A parallel movement, the egg’s rehabilitation as a rich and nutritious food, provided the development of the entire production system through genetic improvement, equipment, and management, thus ensuring market supply at the time of increased consumption (McNamara, 2015; Mottet & Tempio, 2017).

The Food and Agriculture Organization (FAO) projects a 303% increase in egg demand worldwide by 2050 compared to the 2010 production (FAO, 2017). Given this scenario, it is worth studying what conditions Brazil has to participate in the world egg trade, considering that the production growth was sufficient to meet a growing demand for the product, where the Brazilian per capita consumption of eggs increased from 148 units/habitant to 230 units/habitant in 2010 and 2020, respectively (ABPA, 2020).

Another important aspect of egg production is environmental performance since it is regarded as a production with lower greenhouse gas emissions when compared to other sources of animal protein. Moreover, there is still the possibility of mitigating environmental
impacts, especially by the rational use of bio-waste and discards through value-added products (Ladu & Morone, 2021; Leinonen & Kyriazakis, 2016).

The above referred intensification and automation of the production process was positive from an environmental perspective, as it reduced emissions by about 30% when comparing the egg production systems of the 1960s and 2010s in studies conducted in the United States and Canada (Pelletier, 2018; Pelletier et al., 2014).

In Brazil, the commercial production of eggs supplies the consumer market in two main ways: mostly in the form of eggs in natura or table eggs, and a smaller portion is directed to the egg processing industry to obtain egg products, which are mainly used as ingredients in food industries to make cakes, pasta, cookies, mayonnaise, and others. Egg products are more suitable for export due to logistical issues and the product's shelf life. In this study, egg products are defined as the products obtained from the egg, its different components, white or yolk, after removal of the shell and membranes, and which are intended for human consumption and may be added to food products or additives. Egg products can be in liquid, concentrated, dehydrated, crystallized, frozen, and deep-frozen form (Oliveira & Oliveira, 2013).

Commercial production of chicken eggs (in natura and egg products) has different arrangements depending on the country considered. Therefore, this fact may define major producers' positions and importance in the future global scenario, also varying the strategies to expand production and meet emerging issues such as environmental, social (food safety, animal welfare), and economic sustainability.

In China, until 1978, keeping chickens and other birds to produce eggs was not seen as a business, but rather as a by-product of rural life. Currently, the country has varied production systems, ranging from small poultry farms to intensive integrated operations in which large companies control all aspects of the production and trade chain (Yang, 2021).

Chinese egg production is expected to grow, but at a slower pace than in the past. The egg industry's standardization and modernization has been widely accepted as a trend and development strategy. The outcome of this modernization process is expected to be an egg overproduction and, with it, the growth in the activity's impacts, which will require special attention to issues related to biosecurity, waste treatment, and food safety (Yang, 2021).

China's high domestic demand for fresh eggs limits its share in the international egg trade. These consumers value the quality and safety of eggs, and also the environmental issues related to animal production. However, animal welfare generally receives lower priority in
China, which does not mean the absence of interest in studies regarding the topic and the implementation of new welfare-oriented systems for egg production (Yang, 2021).

The United States is a pioneer in the professionalization and intensification of egg production, and in the early 20th century, rural electrification made it possible to create layer hens in sheds, a fact that enabled the year-round egg production in temperate climate countries, no longer being a seasonal food (Pelletier et al., 2018). As of the 1950s, American poultry farmers achieved great economic success with the massive adoption of cage production, and the financial return motivated investment in the production system, a fact that ensured the egg supply for increasingly urbanized consumers by an increasingly small number of farmers (Kidd & Anderson, 2019).

Currently, as in other countries, laying hen breeding in cages is questioned and opposed, leading the US Egg Industry, where about 90% of the flock is housed in cages, to seek alternatives to the stalemate. However, human and laying hens' welfare, along with environmental management, should be at the center of all possible production system changes, considering public opinion as a minor factor (Kidd & Anderson, 2019).

North American egg producers are organized to serve three different markets: the retail market which absorbs eggs in natura or table eggs, another portion of producers serve the egg product processing industries, and a third group produces specialty eggs, such as enriched eggs (selenium, omega 3, and others) and eggs from birds raised out of cages and in organic systems (Malone et al., 2021).

The SARs Cov 2 (Covid 19) pandemic has had effects on the North American egg market, disrupting this market arrangement and increasing table egg consumption due to social isolation. This fact has raised table egg prices, and in an attempt to regulate prices, the producers who sell their production to the industry have been allowed to sell to the retail market. Furthermore, in the pandemic, a reduction in consumers' willingness to pay more for differentiated eggs was noted, which casts doubt on consumers' willingness to pay for animal welfare and environmental sustainability as they seek to meet basic needs (Malone et al., 2021).

In Brazil, egg production was boosted in the last decade of the 20th century, when the production modernization took place. However, the professionalization of egg production in Brazil was already consistent in this period, and technological innovations ensured the domestic market supply and enabled the participation in the global egg market (Mazzuco, 2008).
The Brazilian Association of Animal Protein (ABPA) annually publishes a report on the previous year's production, which includes data regarding commercial egg production. According to this report published in 2019 (ABPA, 2020), there was an increase in egg production and a decrease in the exported percentage. There was a decrease in in natura exports and an increase in egg products total exports (Table 1).

<table>
<thead>
<tr>
<th>Table 1</th>
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<tr>
<td><strong>Amount of eggs produced and percentage of exported eggs in Brazil/year.</strong></td>
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</tr>
</thead>
<tbody>
<tr>
<td>Total produced (in billions of units)</td>
<td>34</td>
<td>37</td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>44</td>
<td>49</td>
</tr>
<tr>
<td>Total exported (%)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>0.4</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Eggs <em>in natura</em> (%)</td>
<td>89.7</td>
<td>89.5</td>
<td>92.0</td>
<td>84.0</td>
<td>61.0</td>
<td>67.0</td>
<td>62.0</td>
</tr>
<tr>
<td>Egg products (%)</td>
<td>10.3</td>
<td>10.5</td>
<td>8.0</td>
<td>16.0</td>
<td>39.0</td>
<td>33.0</td>
<td>38.0</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors with information obtained from the ABPA 2020 website.

Thus, this study aims to present an overview of egg production in Brazil, using time series analysis and scientific literature review, in an attempt to reflect on the position it occupies in the world egg trade, and also to ponder on some factors that may determine the paths to be followed by the Brazilian egg industry.

**Methodology**

The study was based on time series analysis to answer the study's central question regarding future scenarios for egg production and Brazilian eggs and egg products exports. The methodology consists in analyzing a sequence of observations made in a period, analyzing them quantitatively, and projecting future values of a variable based, eminently, on its past observations, organized sequentially and in specific chosen time intervals.

The two main objectives of time series analysis are: (1) identifying the nature of the phenomenon represented by the sequence of observations and (2) predicting future values of the variable of interest in the time series. Pattern identification and model choice in time series data is critical to facilitate predictions. Thus, these two objectives in time series analysis require identification and description of the observed data pattern. Two patterns that may be present are trend and seasonality (Iwueze et al., 2016).
The analyzed sample comprised 20 observations of each variable regarding egg production from 1998 to 2017, corresponding to the production data in tons per year, obtained from the FAOSTAT database and considering four variables:

- Worldwide Production
- Chinese Production - World's largest egg producer
- US production - Second largest producer and with a production base similar to Brazil (approx. 90% of caged hens)
- Brazilian production - Central interest of the study

The export data comprises 23 observations for the period between 1997 and 2019, also comprising four variables, as follows:

- Brazilian fresh eggs exports (in natura)
- Egg yolk powder exports
- Whole egg powder exports
- Total Brazilian exports, variable obtained from the sum of the first three variables, of total exports in tons.

The search for data regarding Brazilian exports was conducted in the COMEX database, linked to the Ministry of Economy, Industry, Foreign Trade, and Services, through the Mercosur Common Nomenclature registration number (NCM). The data are available in kg and were transformed into t for standardization of measurement units (Comex Vis: Visualizações de Comércio Exterior, 2019). This study considered the exports of the following products:

- 04072100 - Fresh eggs of the species Gallus domesticus
- 04081100 - Dried egg yolks (egg yolk powder)
- 04089100 - Dried poultry eggs, without shells (whole egg powder)

Electronic spreadsheets were used to organize the data, and descriptive statistical analysis of the variables considered was performed with the same software, along with the predictive analysis - temporal analysis in the Period from 1997 to 2030 - with a 95% confidence interval. Therefore, actual data from 1998 until 2017 and projections from this year until 2030 were used, considering that production data for 2018 and 2019 were not available in FAO statistics at the time of data compilation for this study.

Linear regression was used for predictive analysis to predict future behavior as a function of past data. The total growth rate over the period and the average annual growth rate of egg production were also calculated, and the Parker (2007) formula was used:
\[ PR = \frac{(V_{\text{present}} - V_{\text{past}})}{V_{\text{past}}} \times 100 \quad (1) \]

The results obtained by the time-series analysis will be interpreted and discussed based on scientific articles relevant to the study's objective.

**Results and Discussion**

The study results and pertinent discussions will be presented in three stages. The first one presents the results concerning egg production in the world, the largest producers in the current scenario, and the results obtained by Brazil. The second stage looks at Brazil's participation in the international egg market. The existence, or not, of the possibility of improving environmental performance in egg production and its operationalization make up the closing of this item, along with a brief reflection on issues relevant to egg production and trade.

3.1 **Egg Production**

The time series for actual egg production (from 1996 to 2017) and predictions until 2030 show an increasing behavior for China, the US, and Brazil, with no periods of reduction in future predictions.

China was the country with the highest average egg production in the analyzed period, corresponding to 37.4% of the world average production. Brazil accounted for about 3% of the average world egg production in the period. It was determined that world egg production in the evaluated countries was asymmetric (mean production greater than median) (Table 2) over the same period.
Table 2

Descriptive analysis of egg and egg product production in Brazil, US, and China compared to world data.

<table>
<thead>
<tr>
<th></th>
<th>Worldwide</th>
<th>China</th>
<th>US</th>
<th>Brazil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average (t)</td>
<td>61.723.693</td>
<td>23.087.314</td>
<td>5.430.017</td>
<td>1.859.550</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>9.662.074</td>
<td>4.228.110</td>
<td>386.212</td>
<td>327.569</td>
</tr>
<tr>
<td>Median</td>
<td>60.660.090</td>
<td>22.562.640</td>
<td>5.384.500</td>
<td>1.811.930</td>
</tr>
</tbody>
</table>

Based on the collected data on totals produced, Figure 2 shows the world egg production in China, the US, and Brazil over the studied period.

Figure 2

Temporal distribution of egg production in the world, China, the US, and Brazil

The world production, and that of the evaluated countries, showed constant growth in the analyzed period, the behavior over the 20 years was similar, and the three countries followed the world growth in egg production.

China had the highest total annual egg production in the period, ranging from 17.4 to about 32,000 tons, making evident its success in structuring and professionalizing egg production in this country, which began in the late 1970s (Yang, 2021). This fact was reflected
in the following decade, when China took the lead in world egg production, surpassing North American production (FAOSTAT - Egg production data, 2021).

Egg production in the US and Brazil, likewise, showed increasing behavior, but with less variability in annual production. This fact can be attributed to the production structure in both countries. In the US, the egg industry has a consolidated intensification and organization process since the mid-twentieth century. While in Brazil, the period corresponds to the beginning of the production units' modernization.

Among the countries considered in this study, the US (second largest producer in the world) showed the lowest growth rates, both accumulated and average per year. It may indicate a saturation of the production system, perhaps because it has been a consolidated and large-scale production longer than Brazil. As a way to better understand this growth in the analyzed period, the cumulative growth rate and the annual average of this growth related to egg production were calculated (Figure 3).

**Figure 3**

*Cumulative and average annual production growth rates from 1998 to 2017.*

China had a growth rate of 3.14% per year, higher than the world rate (3.36%) and lower than the Brazilian (4.17%). Thus, it was found that Brazil had a total growth rate of 83.31%, higher than China's growth (78.76%) in the same period, while the US production had the lowest growth rate per year and total among those evaluated in this study. This result,
slightly higher than the annual and total growth rates in Brazil, can be attributed to the period analyzed, which includes precisely the time of greatest intensification in egg production.

The presented result puts the Brazilian egg industry in an evident growth position supported, mainly, by the production units modernization (Mazzuco, 2008). Based on the historical series considered, predictions and possible scenarios of the egg industry in the world and in the countries targeted in this study were calculated, as shown in figure 4. Considering the prediction between the upper and lower limits, in 2030, China would remain in the lead and account for about 50% of the eggs produced worldwide. Meanwhile, the US would reduce its share of the world egg market from the current 8.4% to about 5.7%, and Brazil would go from the current 3.5% to 3.7% and keep its share of the world egg market virtually unchanged. Since this is a prediction, fluctuations within the upper and lower limits can be attributed to the development strategies of the sector in each country.

Among the countries studied, China shows greater clarity on the future of its egg production, which is oriented towards production growth, at a slower pace compared to its recent past. Therefore, it invests in a standardization and intensification process of the egg industry and identifies its biggest challenges as being, besides the sector's structural changes, the issues related to the innocuousness of the product, environmental safety, biosafety, and food safety.

**Figure 4**

*Production time series (tons) of commercial eggs from 1998 to 2017, with prediction until 2030.*
3.2 Brazilian Participation in the World Egg Trade

Generally, the egg trade takes place in two ways: eggs *in natura* or table eggs (conventional eggs, enriched, from free birds, organic, and others) and egg products (frozen, canned, liquid, powder, and others). Therefore, each country has its internal characteristics regarding the productive organization and the egg market.

In the US, egg trade takes place in a stratified environment where producers serve specific markets, whether for conventional in natura trading, niche-oriented in natura (from free birds, enriched, organic), and eggs for the egg product industry.

In Brazil, the egg market is also organized similarly to the North American one, although conventional egg producers have no commercial restrictions to direct their product, either to the table egg market or to egg product industries (a relatively new option in Brazil), observing the grading rules regulated by the Ministry of Agriculture (MAPA, 2013).

The international egg production and trade tends to expand (FAO, 2017). Furthermore, issues related to innocuousness and logistics may indicate that the international egg trade will also take place in the form of egg products (Table 3). Therefore, this study aimed to understand the Brazilian participation in this international egg market, whether in natura or industrialized. In order to project this future, the time series analysis resource was used based on data from Brazilian exports of the products.

**Table 3.**

*Descriptive analysis of Brazilian egg and egg products exports (tons).*

<table>
<thead>
<tr>
<th></th>
<th>Egg powder</th>
<th>Powdered yolk</th>
<th>Eggs in natura</th>
<th>Total exported</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average (t)</strong></td>
<td>309.14</td>
<td>19.68</td>
<td>3,782.63</td>
<td>4,111.45</td>
</tr>
<tr>
<td><strong>Standard deviation</strong></td>
<td>74.26</td>
<td>5.45</td>
<td>1,367.15</td>
<td>1,340.75</td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>985.6</td>
<td>77.10</td>
<td>17,002.59</td>
<td>17,041.69</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>3.3</td>
<td>0.01</td>
<td>0</td>
<td>24.22</td>
</tr>
</tbody>
</table>

The time series for Brazil's export data are less constant (Figure 5) than the egg production series. The data collected also indicate that Brazil exported a low percentage of its production, a behavior similar to China's 0.25% share of the international egg market (Yang,
2021). Data released by ABPA point 2017 as the year with the lowest volume of egg exports, corresponding to 0.26% of production (ABPA, 2017).

Based on the data series, egg export predictions were calculated until 2030. In 2012, which was an atypical year in the export of eggs in natura, Brazil exported 1.17% of the national egg production. In 2019, this percentage was 0.18%, and for 2030, 0.3% of the national production is expected to be exported. Another movement that can be verified in figure 5 is that the exported products (in natura or egg products) alternate, regarding the exported volume, indicating the substitution and not the simultaneous growth of the exported products.

**Figure 5**

_Brazilian exports of eggs and egg products from 1997 to 2019, with a prediction until 2030._

Generally speaking, predictions indicate a possible future scenario, and cannot be considered an unquestionable reality since many factors can positively or negatively interfere in the predictions’ realization. Some of these factors will be addressed in the next item, such as environmental sustainability, animal welfare, and food safety.

### 3.3 Important Factors for the Egg Industry

Considering there are several factors that impact or will impact the future of world egg production, three of them were chosen for a brief discussion in this study, as follows:
Sustainable egg production

Overall, sustainable production, including egg production, is approached from the sustainability tripod idea: to be environmentally friendly, socially fair, and economically viable. A multidimensional character can also be attributed through institutional sustainability (promotion and regulation of sustainability promotion initiatives).

However, the sustainable production concept is being rethought, giving rise to a systemic approach to sustainability and placing environmental sustainability at the base of everything. In other words, recognizing the interdependence of the different dimensions of sustainability. Once environmental sustainability is contemplated, social sustainability can be achieved, and then economic sustainability (Elkington, 2018; Vaarst et al., 2015).

Considering the systemic vision of sustainability, its environmental dimension should be a protagonist in the strategic decisions of the world egg production. Therefore, conventional production (in cages), according to studies conducted in the US, UK, and Canada, is a system with good environmental performance, especially due to the possibility of efficient management of items such as water, energy, feed, and waste (Leinonen et al., 2013, 2014; Leinonen & Kyriazakis, 2016; Pelletier, 2017, 2018; Pelletier et al., 2014, 2018).

The social dimension of sustainability encompasses several aspects, such as food safety, whether by the products’ innocuousness or by the sufficient quantity to meet the demand for eggs at a fair price. Furthermore, the aspect of technological support for egg production by small-scale egg producers should be noted, especially in less developed countries where egg production guarantees income and livelihood (Mottet & Tempio, 2017).

Production strategies to meet market demand

This study indicated the expansion of the production and commercialization of eggs in the world, and that the trend points to China maintaining its leadership in this sector, reaching 50% of the world egg production in 2030. It can be seen that China has a structured planning that can guarantee this growth with the professionalization and intensification of processes, guaranteeing quantity and quality of the eggs they produce. Animal welfare issues are considered important, but they do not determine the path to be followed in the Chinese production expansion, basing its decisions on meeting the demand and reducing, as much as possible, the environmental impacts resulting from production (Yang, 2021).

The North American egg industry has a long history of organization and professionalization. The intensification of the production process has reduced the environmental impacts of egg production by about 30% compared to the way it was produced in the 1960s and 2010s, a relevant result in environmental sustainability (Pelletier et al., 2014).
However, the North American egg industry has been questioned on animal welfare issues due to the cage housing system for layer hens, which pushed the egg industry to look for alternatives to evolve egg production systems considering welfare and sustainability (Gautron et al., 2021). Although the same public opinion that pushes for cage-free eggs does not always show a willingness to pay for such production, an example of this fact was observed during the SARs Cov 2 (Covid 19) pandemic in the US, where changes in consumption patterns were verified, increasing consumption of conventional eggs in natura, decreasing egg products consumption (widely used in snack bars and restaurants), and also reducing the willingness to pay for special eggs (Malone et al., 2021).

Brazil, which has experienced a large growth in egg production in recent years, will also need to organize the sector to ensure responsible growth, especially to supply the domestic market, ensuring quality and accessibility to all social strata to such an important food, besides thinking about issues related to the product's industrialization and exportation in a sustainable way. Therefore, the pathways for the Brazilian egg industry in the future, as in other countries, should contemplate human and poultry welfare, and also the environmental management (Kidd & Anderson, 2019).

Such choices should consider food safety and environmental efficiency of housing systems, sideling public opinion, which is not always fully enlightened of all the factors involved in industry decision-making (Kidd & Anderson, 2019). Thus, it is appropriate to paraphrase Vaarst and Horsted, when they say that: "If there is a real option for consumers to choose poultry products according to their preferences, they need to be aware of and well-informed about the background and possible consequences of production methods, and this necessarily means a certain degree of industry transparency" (Vaarst et al., 2015).

Circularity in the egg industry

Egg production sustainability is closely linked to nutrient circularity, through the systematic transformation of its bio-waste and discards into value-added products (Ladu & Morone, 2021).

Attitudes that contemplate the mitigation of environmental impacts are considered valuable to ensure the sustainability of any production. Therefore, giving correct destination to waste such as manure and eggshells from the egg product industry, use of clean energy, organic fertilization, among others, are initiatives that contemplate the closing of the cycle and guide the sector to a sustainable production (Ladu & Morone, 2021).

Thus, production systems must necessarily contemplate waste management and, in this sense, we can think about the future of the egg product industry and one of its main
residues, eggshells. Eggshell is a waste product that represents about 10% of the weight of an egg, and is composed of about 94% calcium carbonate. Its reuse, besides meaning a reduction in environmental impact, characterizes an economy of extracting calcium from nature, an exhaustible natural reserve (Kanani et al., 2020).

Therefore, research and technology development for new waste recovery strategies are required to support increased detour of underutilized waste streams, including eggshells, dead poultry carcasses, and laying hens (Pelletier, 2018).

**Conclusion**

The analysis of the results indicates growth in the period considered, whether those already consolidated or as statistical predictions, both of world egg production and the activity's growth in Brazil, including egg and egg product exports. These results indicate productive growth and a trend towards the insertion of products in the commercial laying poultry industry, in the foreign market, and a consequent growth in the generation of residues from productive activities.

According to the analysis performed, Brazil occupies a relevant position as a commercial egg producer, and there are possibilities to expand the production of eggs *in natura* and egg products and, based on these facts, by 2030 the country will be led to a more effective participation in the international egg market. Thus, it becomes necessary to plan the necessary expansions, based mainly on issues related to environmental performance and food safety (quantity and safety), to ensure the access of different social strata to this valuable animal protein source.

Therefore, the relevance of further studies on waste management in the production chain of commercial eggs is emphasized. In order to do so, it is important to know its characteristics and volume, and also to catalog the possible alternatives for its use in other productive processes, either by mitigating environmental impacts, or by the opportunity for its commercialization, or by reducing the extraction of natural resources, which the waste reuse can represent.

The efficient waste management, especially the organic ones, can result in economic gains and competitive advantage in conquering new markets for its trading and, in some cases, the negligence with this theme can result in trade barriers.
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