Colegio de Postgraduados

# Yield evaluation of broiler carcasses from a poultry processing plant with automated processing conditions in the Colombian Eastern Plains

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**ABSTRACT**

**Objective**: To evaluate the yield of dry and hydrated broiler carcasses from two suppliers that manage technical poultry processing plants in the Colombian Eastern Plains, per department (Cundinamarca and Meta) and per sex (females and males).

**Design/Methodology/Approach**: A total of n=777 broilers were used for carcass yield analysis, n=398 and n=384 of which were provided by supplier A and supplier B, respectively, with an equal proportion of females and males. Inferential statistics (ANOVA test) and descriptive statistics were used to determine the behavior of the analyzed variables, with the aim of determining a significant difference between the variables.

**Results**: Supplier B recorded the highest yields: an 11.93% increase in carcass after pre-chiller and chiller. The plains area near the processing plant of Cumaral recorded better results: 2.79% higher than the live weights of the Cundinamarca area. In the comparison by sex, the males were dominant, since their live weights were 5.47% higher and the carcass weights were 6.67% higher than in females.

**Findings/Conclusions**: After the pre-chiller and chiller processes, the yield of the poultry meat production chain at AVIMA S.A. was >10% (weight increase of the dry carcass). In conclusion, the optimal stimulation of bird pores and the cooling generate profits in weight.

**Keywords**: Carcass, efficiency, broiler, production, yield.

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## INTRODUCTION

Worldwide poultry production used to be a secondary activity within the agricultural sector in charge of farmers and has now become a true industry. According to the UN (2022), this sector continues to grow and industrialize in many parts of the world, as a consequence of the powerful boost of demographic growth, purchasing power, and urbanization processes. Furthermore, this industry includes not only egg production, but also the industrial and high-tech production of poultry meat (Saenz, 2022).

Poultry companies have made great efforts to identify new technologies in production systems, with the aim of generating greater productivity and reducing production costs (Montero, 2020). The yield of broiler carcasses is one of the most important economic profitability parameters (Sanz, 2021; García *et al.*, 2009). This parameter is generally measured in eviscerated broiler (*i.e.*, blood and feathers are considered losses). Processing companies choose to obtain high-range yields and consider the conditions that affect broiler carcasses (Gillén *et al.*, 2015).

According to the International Organization for Animal Health (OIE, 2010), an animal with adequate well-being fulfills the following parameters: it is healthy, it is well fed, and does not suffer from unpleasant sensations (pain and fear). In this regard, Cockram *et al.* (2004) mention the five freedoms that ensure animal well-being: they must not be hungry or thirsty; they must not experience an insufficient level of nutrition; they must not present pain, injuries, or illnesses; they must not feel fear or distress; they must not be uncomfortable; and, finally, they must show a natural behavior.

Regarding the Colombian animal protection and welfare legislation, the Ley N° 84 -Estatuto Nacional de Protección de los Animales includes wild or unbridled, domestic and domesticated species, both captive and in their natural habitat (FENAVI, 2019). However, the law was modified and Ley 1774 of 2016 is currently applied in the country. Indeed, Romero and Sánchez (2011) mention five explicit provisions in health legislation regarding primary production.

In this sense, this research compared the yield of dry and hydrated broiler carcasses under different conditions (by departments, by sex, and by geographical areas), in order to determine the incidence of these percentages, as reported in the bibliography. These conditions must be regularly measured and analyzed to ensure that production standards are being met. In addition, monitoring the capacity, flexibility, and sustainability of the processing plant is also essential to ensure efficient and sustainable long-term operation.

## MATERIALS AND METHODS

The research was carried out at the La Balestra station of Avícola del Magdalena S.A. (AVIMA S.A.), located in the municipality of Cumaral, department of Meta, Vereda de Presentado lane, Km 10 of the Vía Yopal Casanare road (4° 17' 41.7" N, 73° 23' 58.9" W). The average ambient temperature was 23.6 °C and the relative humidity was 58%. This company processes poultry through the application of knowledge and updated technical systems.

### Sampling Description

The 30-day work began with a total sampling of n=777 broilers from two main suppliers, supplier A and supplier B (n=393 and n=384 broilers, respectively). The birds were received, weighed, and marked in the hanging area (Figure 1).

Subsequently, the broiler samples were subjected to processing and cooling to confirm the weight of dry (after evisceration and before internal-external washing) and hydrated (after the chiller and draining process) carcasses. The weight data were recorded daily, classified by suppliers and by departments of origin (Cundinamarca and Meta), and tabulated in

**Figure 1**. Broiler weighing.

Excel worksheets for control purposes. A response variable was calculated, which was the weight of the birds under four different conditions: A) birds supplied by supplier A; B) birds supplied by supplier B; C) birds from the department of Cundinamarca; and D) birds from the department of Meta (Llanos Orientales).

### Statistical analysis

With the aim of determining the behavior of the analyzed variables, inferential statistics (ANOVA test) were used to observe a significant difference between the variables. Descriptive statistics were applied to the analyzed weights, determining measures of dispersion (mean, standard deviation, sample variance, and coefficient of variation) for the proposed variables. The R statistical software was used for the analyses with a 95% significance level.

## RESULTS AND DISCUSSION

The average of the broiler live weight, dry broiler carcass weight, and broiler carcass after the pre-chiller and chiller processes weight were tabulated in order to compare the yields of the carcasses from two suppliers (supplier A and B), per sex (female or male) and per department (Cundinamarca and Meta) (Figure 2).

### Supplier classification

One of the indicators that affect suppliers is the yields of broiler carcass. Supplier B has better production, reaching yields of 73.94% in dry carcasses and 82.76% in cold carcasses (after pre-chiller and chiller). The carcass weights increase by 4.5%, after they are kept for 15 to 20 min in a chlorinated water solution of no more than 50 ppm, a pH of 6-7, and a temperature of 22 to 28 °C (Galarza, 2011). Taking into account the data graphed above (Figure 2), the weights of the dry carcasses increased in the pre-chiller and chiller by 11.55% (supplier A) and 11.93% (supplier B). The analysis of the results shows that the good manufacturing practices and operational actions of supplier B are better.

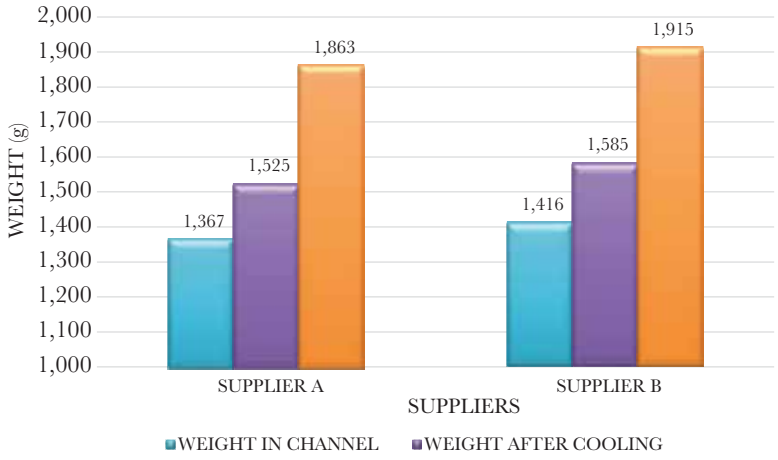


**Figure 2**. Comparison of carcass weight of poultry from suppliers A and B.

## Classification by departments

The location of the producing farms and the transportation times of the animals can affect the yields. The following table shows the average yields of the farms located in two different areas (Cundinamarca and Llanos Orientales).

Since the processing plant is located in the city of Cumaral, Meta, transportation time affects the yield of the carcasses from Cundinamarca (poultry production farms are an average distance of 68 km from the processing plant). In their research about the well-being during transport and quality of meat, Ruiz and Manteca (2002) determined that broilers can lose between 5 and 10% of their live weight during the journey from the farm to the processing plants. This research determined that the live weight of the broilers from Cundinamarca is 2.79% lower than in Llanos Orientales (poultry farms are an average of 7 km away from the processing plant). This reduction is explained by the longer time elapsed between fasting and processing and the additional stress experienced

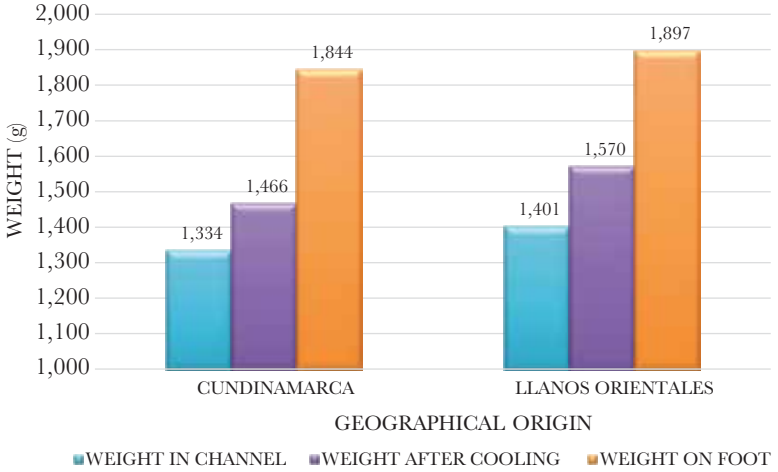


**Figure 3**. Average broiler carcass weights according to geographical area (Cundinamarca and Llanos Orientales).

by broilers from farms located in areas further away from the processing plant (in this case, in Cumaral, Meta).

Other factors that affect the carcasses are edaphoclimatic conditions. In their development stage, broilers have scarce ability to regulate their temperature; therefore, they need an average temperature of 30 °C and a relative humidity between 60-70% (Aviagen, 2009). However, these conditions are difficult to comply with in geographical areas such as Cundinamarca, where the average temperature ranges from 14 to 18 °C (IDEAM, 2020).

The Avima company carries out a three-stage process which includes: a scalding process; a cooling process with a pre-chiller and chiller and rinsing the carcass to remove excess blood. This threefold process seeks to ensure that the sudden changes in temperature allow water to enter the protein of the poultry, through the pores dilated during the scalding process (Fajardo, 2014), generating a significant increase in weight and a relative price gain for the company. For their part, Mir *et al.* (2017) mention that "water content and its distribution within the meat have a great influence on its quality and economic value." In conclusion, several factors affect the water retention capacity (WRC) of the muscle proteins of poultry; in turn, each of the factors clearly depends on the increase in the production of lactic acid resulting from bird stress.

The comparison by departments of the two main suppliers determined that stress is one of the primary aspects that significantly influences the yield of the carcasses. Figure 3 shows a significant difference between yields: the department of Meta has a higher percentage of both dry carcass yield and hydrated carcass yield than the department of Cundinamarca. According to Gillén *et al.* (2015) an animal shows stress when its movements are restricted and it is handled inadequately, it undergoes occasional fatigue, pain, or injuries, objects, or people foreign appear in its usual environment, or it suffers from hunger, thirst, or lack of thermal comfort.

Additionally, stress affects the yield of the poultry because the flocks in the sheds are usually transported to destinations located several hours away (Cundinamarca-Cumaral). In addition, stress is also generated by an inadequate harvesting management on the different farms, which affects the water retention capacity (WRC) in the processing stage, as a result of changes in lactic acid. As indicated by Perez (2018), the impact of WRC is caused by the increase in lactic acid and the decrease in pH in the meat.

Consequently, animal welfare is a major issue that affects the quality of meat in processing companies. As it moves away from the isoelectric point of proteins (5.1-5.5) (Moreno, 2005), the pH increases the WRC and improves the ability of the meat to retain water (Viteri, 2013). It is inferred that, being closer to the processing plant, the poultry from the Department of Meta did not have to undergo so many hours of transportation, which would have increased the lactic acid in their body (as a consequence of stress); the opposite phenomenon has been recorded with poultry from of the Department of Cundinamarca.

**Classification by sex**

De Obaldia and Perales (2015) studied the production of males and females of the Arbor Acres Plus® line and determined that, after 32 days, the males were 11.64% heavier than the females, based on the average weights shown in Figure 4.

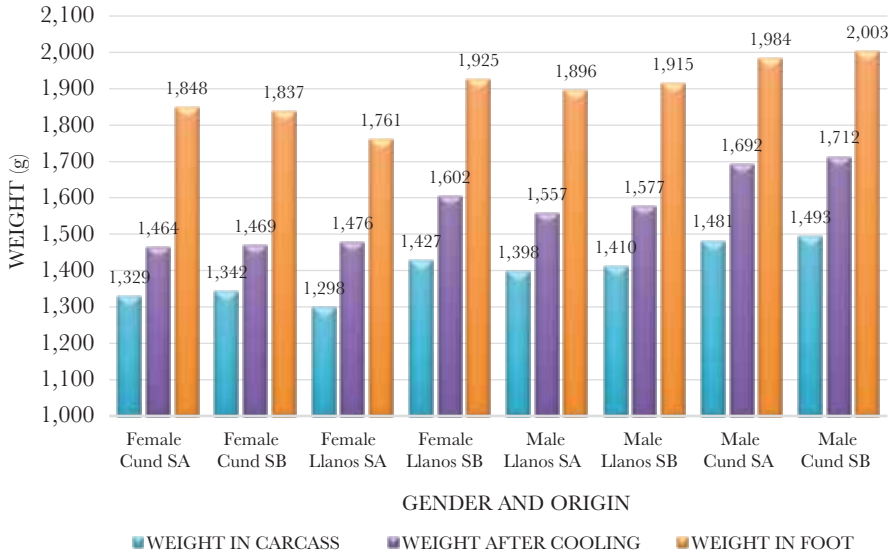


**Figure 4**. Average broilers carcass weight according to sex (male and female) and supplier (PA: supplier A; PB: supplier B), in the different geographical areas (Cundinamarca and Llanos Orientales).

The carcasses were compared by sex (female and male) and area of origin (Cundinamarca and Meta). When live weights were taken into account and the carcasses were compared before the cooling process, males exceeded the yield of females by 5.47%. Likewise, the males recorded a 6.67% higher carcass yield (average: 74.13%), resulting in a higher food/meat conversion. After the pre-cooling and chilling processes, carcass yields were 83.83% for males and 81.55% for females. On average, WRC yields in males were 1.39% higher. According to FENAVI (2019), the greater weight gain of males is also partially as a result of the considerable increase in their average daily consumption during the fattening or finishing stage. Males consume an average of 142.28 g of food per day for three weeks, with 15 to 20% increases in consumption each week, reaching a weight gain of 391.2 g poultry$^{-1}$. The external conditions of the well-being of an animal before it enters a technical processing plant play an important role in the yield of the carcasses. Those conditions are related to the water retention capacity and influence the increase or decrease in lactic acid in the animal's body. The poultry industry should take into account the external conditions to which animals are subjected (*e.g.*, transportation), if they are to prevent monetary loss resulting from the failure to achieve the expected yields in their daily production. The temperature and relative humidity of the farms greatly influence the performance of weight gain in broiler chickens. Finally, the viability of production in cold climate areas is related to the atmospheric conditions of the producing farms.

## CONCLUSIONS

The external conditions that link animal welfare prior to entering a highly mechanized processing plant play a significant role in carcass performance, as the water retention capacity is closely associated with variations in lactic acid content in the animals' bodies.

It is imperative for poultry industry stakeholders to take into account external conditions, such as transportation, in order to prevent financial losses resulting from not achieving the expected daily production yields.

Temperature and relative humidity in poultry facilities have a significant impact on the weight gain of broilers and broiler hens, and the viability of production in cold climate areas is largely contingent on atmospheric control in the producing farms.

The poultry meat production chain in Avima has >10% yields (weight increase of the dry carcass) after the pre-chiller and chiller processes. In conclusion, the optimal stimulation of the pores of the poultry and the cooling generate an increase in weight.

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