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**OFFICIAL HEALTH METHODS TO DETERMINE WATER RATES IN  
BROILERS' CARCASSES: AN EVALUATION**

**SANTOS DVS<sup>1</sup>, BARROS LSSE<sup>2\*</sup>, MASCARENHAS MTVL<sup>1</sup>, LIMA KC<sup>1</sup> AND CRUZ  
ALD<sup>1</sup>**

**1:** ADAB, Avenue Adhemar de Barros 967, Ondina, Salvador BA, Brazil, 40170-110

**2:** Center of Agrarian, Environmental and Biological Sciences, (CCAAB), Federal University of the Recôncavo Baiano (UFRB), Rua Rui Barbosa, 710. 44380-000, Cruz das Almas, Bahia, Brazil

**\*Corresponding Author: E Mail: [barros@ufrb.edu.br](mailto:barros@ufrb.edu.br); Ph.: 00 55 75 3621 9751**

**ABSTRACT**

The experiment was carried out in a poultry slaughterhouse under the state official supervision of Bahia, in the Reconcavo Baiano, BA, Brazil. The Internal Control Method was carried out with 12 chickens a day for 15 days. Evaluated samples were packed, properly identified with numbered seals and frozen. Ninety-six chickens within the total number of frozen samples were frozen without guts and 84 with guts. The Drip Test was performed according to the official methodology (MAPA, Ordinance 210/1998). Results showed positive correlation ( $r= 0.744$ ,  $p\leq 0.001$ ) in statistical analysis between the two tests, with mean  $5.94\% \pm 1.35$  for the internal control method and  $4.91\% \pm 0.97$  for the Drip Test, which corresponds to  $1.03\% \pm 0.90$  between them. Lighter carcasses absorb more water and no relationship with regard to the presence or absence of guts was reported when carcasses were frozen.

**Keywords: Chicken Cooling; Water Absorption; Drip Test**

**INTRODUCTION**

The meat market in Brazil and worldwide is increasingly competitive and complex [1] and its evolution is affected by commercial and production demands. The development of industrial avian culture and agro-

industrial segments and their expansion in many areas in Brazil, especially in the first decade of the 21<sup>st</sup> century, has been caused by technological innovations that increased

the industries' productivity, production and assets.

Consumers' behavior and broiler market competitiveness required the development of quality management in the avian industry, inserted within a strategic stance mainly to satisfy its clients. The above factors are highly important for abattoirs and should be taken into consideration since Brazil intends to be a leader in broiler exportation [1].

Different cooling methods affect the quality aspects of the final product [2]. The cooling process, carcass hydration and cuts in the broiler industry in Brazil are made feasible and accelerated by chillers. Cooling procedures eventually accumulate a percentage of water absorption in carcasses and constantly monitored by the Government Inspection Service which established a threshold percentage of absorbed water [3].

Carcasses are cooled in chillers during their transition through tanks and the cooling process occurs by the direct contact of the carcasses with water and ice. Chillers are semi-cylinder-shaped with an internal helicoid that moves slowly and displaces the carcasses [4]. However, more demanding markets do not accept cooled chicken meat by water immersion systems [5].

The Brazilian Ministry of Agriculture, Fisheries and Supply (MAPA) regulated the

Technological and Hygiene-Sanitary Inspection of chicken meat by Ordinance 210 of the 10<sup>th</sup> November 1998. Pre-cooling procedures is the process by which a lowering of temperature of poultry carcasses is undertaken immediately after the gutting and washing stages. It is performed by immersion in cold water or in water and ice or by passing through a cooling tunnel [6].

Absorption index is the water percentage acquired by poultry carcasses during the slaughtering process and other technological procedures, especially during the pre-cooling immersion system. A small percentage of absorbed water, averaging up to 3%, is retained during scalding, plucking and several washings in the gutting process. The quantity of water determined by the Internal Control Method, one of the official methods, is given in percentage of total weight of poultry carcass, or rather, up to 8% of weight as the maximum limit. The Drip Test is undertaken with frozen chickens at a 6% limit for an average of 6 carcasses [6].

According to [7], cooling is a widely used method to extend meat shelf life. Low temperature delays microbial activities and chemical and enzyme reactions that cause changes in the meat. As a rule, meat is cooled at 1 to 5°C, whereas temperature for freezing should reach at least -2°C.

Water absorbed during pre-cooling by immersion is directly and mainly related to the temperature of water in coolers, permanence in the system, type of abdominal cuts, air injection in the system (bubbling) and other less important factors [6]. The higher the temperature and water agitation, the greater is the carcasses' absorption of moisture [8].

Poultry carcasses' pre-cooling is undertaken for the production of safer products through temperature decrease. Consequently, growth rates of deteriorating microorganisms are lessened and the increase of most pathogenic microorganisms impaired [2]. According to [9], microbial contamination is reduced only at the start of the finishing activities when the parameters of chloration and water flow are inadequate. It also affects the main indicators of meat quality, such as taste, form and texture [10].

Current analysis evaluates the results of two official methods for the control of water absorption index by poultry carcasses on pre-cooling by immersion in water, verifies influence on giblets and guts, and compares moisture loss when the two tests are applied.

#### **MATERIALS AND METHODS**

Assay was performed in a poultry abattoir, in the Reconcavo Baiano area, BA Brazil, controlled by the state inspection service, with a daily slaughtering production of fifty thousand broilers. The abattoir lies within

the control of the Brazilian Inspection System (SISBI) of the Unified System for Agricultural and Animal Breeding Health Care (SUASA) and in conformity to Ordinance 210 of November 1998 [6] with regard to the technological poultry processing.

The industry concerned has two carcass cooling equipments, or rather, a pre-chiller and a chiller, manufactured in stainless steel 304, with 2mm-thickness and 6m- and 9m-long respectively.

Ice in the cooling equipment is supplied by a galvanized ice screw, 7m in length and a motor redactor of 5 hp. Moreover, 750 kg of ice are supplied to the pre-chiller at every 20 min. Since the industry's daily hour load of broiler slaughter is 530 min, total ice per day amounts to 20.250 kg. Besides the above calculations, in the case of the chiller tank, there is a 3,200 kg increase from ice discharge at every 5 min. Total ice amounts to 23,450 kg in the second equipment.

Warm-water tank for the Drip Test, trademark Silveira, is made of stainless steel AISI 304, with water warming system produced by electric resistance to warrant a temperature of  $42^{\circ}\text{C}\pm 2^{\circ}\text{C}$ .

Current research consisted of two phases (A and B) which included the internal control method (A) and the Drip Test (B). Phase B was subdivided into two other stages (B1 and B2).

Twelve broilers' carcasses were collected daily, during 15 days, directly from the scoop-wheel after the gutting and washing stages. Samples were identified with numbered seals and submitted to the Internal Control Method according to official methodology described by the Ministry of Agriculture, Fisheries and Supply Ordinance 210/1998. Data were registered on sheets and permanence time of the carcasses in the pre-chiller was reported. Immediately after the Internal Control Method in the first phase of the experiment, the samples were packed, together with viscera and giblets, and frozen. After 24 hours, the Drip Test was applied to the samples comprising 84 carcasses. The second phase comprised 96 samples, frozen without viscera and giblets. The samples were kept sealed so that data could be compared.

Isolated from the other processed product, the packed products, placed in white plastic boxes, were stored in a cold chest for 24 hours. Samples were removed from the ice chest after completing the freezing process and seal number of all samples was verified. Descriptive and analytic data analysis was undertaken by Statistical Package for the Social Sciences (SPSS 13.0). Distribution and frequency of information were thus obtained by the determination of central and dispersion trends, featuring their qualities;

multi-variegated analysis by Pearson linear co-relation ( $r$ ) was applied to describe the association between the variables for continuous data. Behavior of variables was verified by scatter plots in the previous stage prior to the analysis of Pearson co-relation.

## RESULTS AND DISCUSSION

The refrigeration processes affected the biochemical reactions and the structural changes that occurred in the muscle during the first 24 hours post mortem. In fact, they have an important role in the meat's final quality and taste [10].

Moreover, 85% of water remained within the muscle's myofibrillar. Water de-freezing occurred during the conversion of the muscle into meat and different cooling temperatures affected the above dynamics. When fast cooling occurred, loss by drips decreased due to pH lowering and, consequently, in the post mortem glycolysis. Temperature actually interfered in water distribution and mobility within the muscular tissue [11].

When results from water absorption in broilers' carcasses after the cooling stage by the Internal Control Method (**Figure 1**) were evaluated, 14 (7.8%) out of the 180 carcasses analyzed showed rates above normal (8% of water absorption). Absorption ranged between 3.3 and 10.72.

When the frozen carcasses were analyzed individually with regard to water absorption rate by the drip test, 21 (11.7%) out of the 180 carcasses analyzed showed a higher rate than normal (6% water absorption) (**Figure 2**). Absorption by drip test ranged between 3.09 and 8.33.

**Table 1** shows loss of moisture in carcasses, which occurred between the cooling stage and after freezing, with mean  $5.94\% \pm 1.35$  for the Internal Control Method and  $4.91\% \pm 0.97$  for the Drip Test, with a  $1.03\% \pm 0.90$  relationship.

According to [2], when carcasses were immersed in water at temperatures above  $12^{\circ}\text{C}$ , water absorption between 12 and 15% of weight occurred. [12] showed that cooled carcasses in immersion tanks absorbed mean 11.7% of moisture, 4.72% of which were eliminated within 24 h of storing. [8] reported that when carcasses were removed from the chiller, minimum hydration was estimated at 14%. In fact, 2% were lost during dripping. Data by [13] demonstrated that 50% of water was absorbed within the first 10 minutes after immersion, due to the influence of hydrostatic pressure.

Carcass cooling in an immersion chiller had better cost effectiveness and a more agreeable taste when compared with that of carcasses cooled by air apparatuses. The latter is not only less efficient but also more expensive [2] by about 30% [5]. The

European market requires the air system due to traceability and low (about 1%) water absorption rates [5].

[14] reported that the pre-cooling stage might be eliminated in the process, without any liabilities in color, weight loss by cooking and breast tenderness, even though the same authors did not evaluate the products' microbiology. Crossed contamination in broilers' carcasses might occur both in the immersion system, in cold water or in water and ice, and in the air system [15].

Analysis on the relationship between absorption percentage and average weight of animals showed mean 6.5 absorption and 2,258g weight (**Table 2**). Animal weight ranged between 1496g and 2430g and evidenced samples' homogeneity. **Figure 3** demonstrated that there was an average negative correlation between the two variables ( $r = -0.431$ ,  $p \leq 0.001$ ).

[12] also reported that relative water absorption in small carcasses was even higher when compared to that of carcasses with greater weight and that immersion time was the most important variable associated with water absorption. [2] registered that broilers' carcasses weighing between 1.36 and 1.6kg, had 11.7% weight increase when immersed in water and ice.

Time monitoring of carcass permanence in the pre-chiller should be undertaken at the

same time as the absorption test. In this case, time was calculated from the moment in which carcasses were submitted to the absorption test until the exit of all carcasses during the first pre-cooling stage [16]. The stage should not take more than 30 minutes [6, 16]. Maximum time in the course of current study was 20 min, with minimum oscillations between 15 and 20 min.

A variation between 3.31 and 10.73% in the absorption method and between 3.09 and 8.33% in the Drip Test was reported for the 180 broilers under analysis. On the other hand, the statistical analysis to evaluate the correlation between the two variables showed high positive relationship ( $r=0.744$ ,  $p\leq 0.001$ ), as **Figure 4** shows. The proportionally direct relationship meant that the higher the results in the absorption test, the higher were those of the Drip Test.

Drip Test controlled water absorption of carcasses for commercialization as frozen products, with or without giblets [16]. Decree 20 published on 21st July 1999 by MAPA indicated the Physical and Chemical Analytic Methods for the Control of Meat Products and other Ingredients, which is not applicable to broilers treated with polyphosphates or with other compounds that increase water retention [17].

The Prevention and Control of Water Addition to Products Program should foresee the collection and analysis of at least

one sample (with 6 units) per slaughter shift. Moreover, official verification should follow up 20% of tests undertaken weekly by the firm [16].

Ninety-six out of the 180 analyzed samples were packed without viscera and 84 samples had a secondary packing with the viscera. Pearson linear co-relation demonstrated that packages with or without viscera had a high positive relationship with absorption percentage and the result of the drip-test,  $r = 0.747$  and  $r = 0.754$  ( $p\leq 0.001$ ), respectively (**Figure 5**).

According to [6], an average of 3% water absorption occurred during the initial stages of slaughtering (scalding, plucking and the various washings during evisceration). The remaining absorption occurred during pre-cooling in cold water immersion chiller. Cooling of giblets occurred under continuous refrigeration, by immersion, with worm drive screws, at a maximum 4°C and constant water renewal, in the opposite direction to the movements of the same, at a minimum proportion of 1.5 liters per kg.

Immersion in chopped ice was even more efficient than immersion in water at the same temperature [2]. Chopped ice in the tanks was employed in the industry in which the experiment was performed. Temperature effects on duck meat quality were evaluated by [18]. Duck carcasses underwent three different types of cooling temperatures,

during 30 minutes. Whereas the temperature of water and ice was 0°C, that of cold water and water was respectively 10°C and 20°C. Results showed that temperature differences failed to interfere in meat quality, with the exception of its coloring.

Meat firms in Brazil are responsible for the application of procedures with regard to control and monitoring of processes on limits fixed by current legislation. In the pre-chiller process, process control should comply with parameters mandatory for the control of temperatures, continuous renewal of running water, permanence time of broiler carcasses in the apparatus, bubbling and dripping. Minimum frequency of monitoring should not be over two hours [16]. Average absorption percentage ranged between 4.84 and 4.97% respectively when absorption percentage of frozen carcasses with or without giblets was analyzed (Table 3).

According to [19], products' shelf life is generally determined by texture, physical aspects, taste, color, microbial activity and nutrition values. The above factors are affected by storing, freezing and de-freezing. However, the processes did not decrease the number of viable microorganisms that were dormant up to the thawing period in which they recover their activity. In the case of the efficiency of pre-cooling tanks with regard to decrease in

microbial contamination of broiler carcasses, [9], reported faults during control of variables that interfered in the results. Insufficient water flow, inadequate coloration and water temperature above the normal one during the pre-chiller and chilling phases in some evaluations determined data, especially at the end of the slaughtering shift when they were especially high.

### CONCLUSIONS

- Low-weight carcasses absorb more water than heavier ones;
- The higher the water absorption by cooling in immersion chiller, the higher is the result of the Drip Test;
- Freezing of carcasses with or without viscera fail to interfere in the results of Drip Test.

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**Table 1: Descriptive Analysis Between Moisture Rates of Water Absorption Tests in 180 Broiler Carcasses**

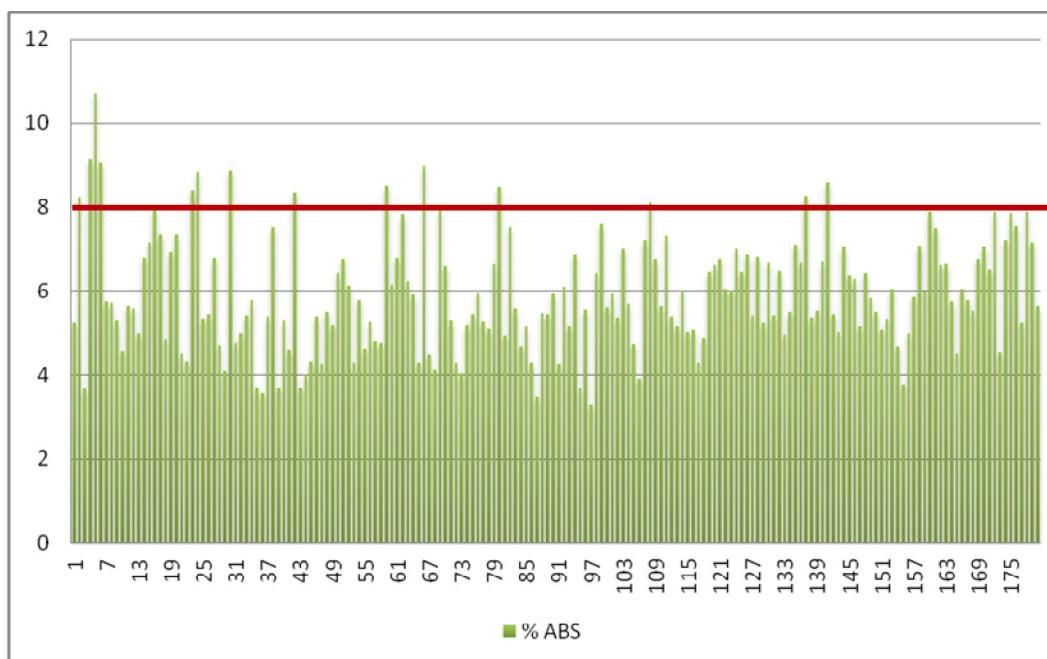
	N. of samples	Minimum	Maximum	Mean	Standard deviation
% absorption	180	3.30	10.72	5.9383	1.35282
% drip test	180	3.09	8.33	4.9073	0.96762
difference abs X drip	180	-1.65	4.42	1.0310	0.90375

**Table 2: Descriptive Statistics of Percentage (%) of Absorption and Mean Weight of Broilers (g) in 180 Samples**

	Mean	Standard deviation	Minimum	Maximum
% absorption	5.9383	1.35282	3.30	10.72
Animals' average weight	1860.89	189.852	1496	2430

**Table 3: Descriptive Statistics of Water Percentage in Individual Drip Test in Frozen Carcasses of 180 Carcasses, with and Without Giblets**

Viscera	N. of samples	Mean	Standard deviation	Minimum	Maximum
No (individ. drip %)	96	4.9751	0.93894	3.09	7.72
Yes (individ. drip %)	84	4.8299	0.99939	3.27	8.33

**Figure 1: Control of Water Absorption in Percentage, Taking into Consideration Official Requirements (max. 8%), by the Internal Control Method, with 180 Broiler Samples After Cooling by Immersion Chiller in Water and Ice**

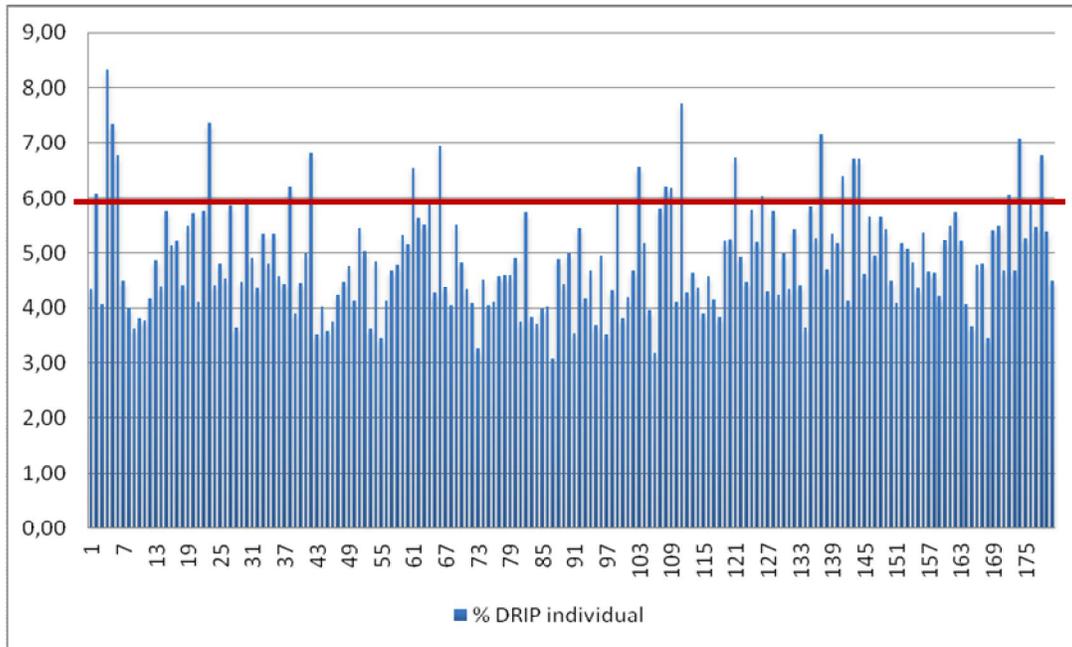


Figure 2: Result of Drip Test by Individual Analysis of Frozen Carcasses, According to Legal Requirement (max. 6%), following Ordinance 210/1998

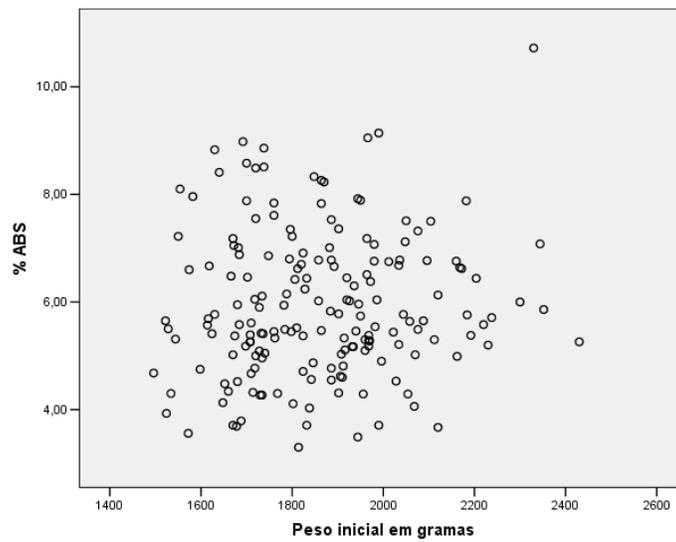


Figure 3: Scatterplot with Percentage Variables of Absorption and Mean Weight of Broilers (kg) of 180 Individual Samples

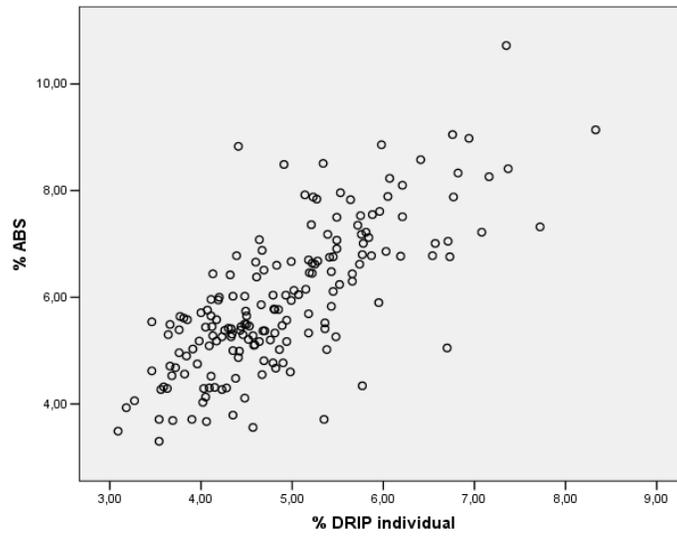


Figure 4: Scatterplot with Percentage Variables of Absorption and Drip Test Result (%) of 180 Individual Samples

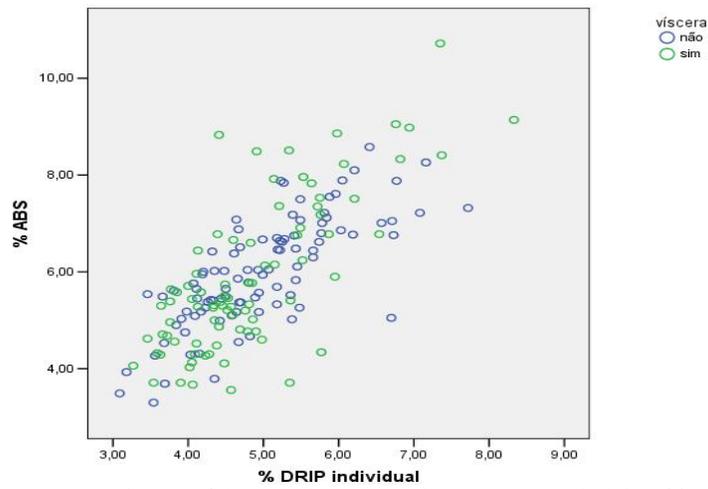


Figure 5: With Percentage Variables of Absorption and Drip Test Result (%) in 180 Individual Samples of Frozen Broiler Carcasses with and Without Giblets