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PREVALENCE OF STUNNING METHODS IN BROILER CHICKEN SLAUGHTER IN THE UNITED STATES

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EXECUTIVE SUMMARY Electrical stunning is the most commonly used method for pre-slaughter stunning of broiler chickens. Despite its widespread usage, this method has several negative welfare implications and low efficacy. More humane alternatives such as controlled atmosphere stunning or low-atmospheric pressure stunning are being adopted by slaughter plants worldwide. Using publicly available data, we estimate the prevalence of the various stunning methods employed in chicken slaughter in the United States. We found that in 2019, 92% of chicken slaughter used electrical stunning and 7% controlled atmosphere stunning, while 1% of chickens were slaughtered without stunning.

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The research presented in this document displays the *Open Data* badge for open science practices. All data are available in the associated Open Science Framework repository at https://osf.io/5nbys/.

CONTENTS

1. INTRODUCTION

Today the majority of broiler chickens in the United States (US) are stunned using electrical stunning prior to slaughter [1]. With this method of stunning, conscious birds are hung by their legs upside-down on a moving metal shackle line and their heads pass through an electrified water-bath before their throats are cut. Electrical water-bath stunning was created to allow fast processing of birds, with line speeds of up to 175 birds per minute [2]; however there are many welfare problems associated with this system. The birds' legs are compressed during shackling, causing pain [3], especially in birds with thicker legs or suffering from painful lameness due to leg diseases, bone dislocations or fractures, which is present in one out of three birds [4]. Bird inversion increases the levels of stress and anxiety that poultry are subjected to during the shackling process [5]; due to their lack of diaphragm, chickens' lungs may be crushed by their organs. Rough shackling can significantly contribute to wing flapping leading to dislocations and bone breakages. Pre-stun electric shocks are not uncommon as the birds' wings make contact with the water-bath before their heads [1; 6; 7].

Furthermore, electrical stunning is often not completely effective. Some birds are not properly stunned because they miss the stunner by raising their heads and missing the water [8]. When the birds' heads do enter the water-bath, the electrical current may be too low to induce unconsciousness as the current which passes through individual birds is highly variable in a multiple-bird water-bath [9; 10; 11]. Birds can be electro-immobilized, in which the birds are paralyzed and their physical reflexes are absent but they are still conscious. Therefore, it is difficult to distinguish an electro-immobilized conscious bird from a stunned, unconscious bird [1; 12]. There is also the issue of meat quality, which is improved with high frequency waveforms but in turn reduces the effectiveness of the stun [9; 13]. It has been claimed that in commercial practice only about one third of birds are effectively stunned [14]. An evaluation of the post-stunning survival rate in Belgian poultry slaughter plants found that 96-100% of sampled broilers regained consciousness after electrical waterbath stunning [11].

Controlled atmosphere stunning (CAS) or controlled atmosphere killing (CAK) has become increasingly common during the last 20 years in Northern Europe, mainly as a result of the animal welfare and product quality advantages in comparison with electrical stunning [1]. CAS/CAK works by exposing broilers to either carbon dioxide (CO_2) or a mixture of inert gases (argon, nitrogen or both), causing a reduction in available oxygen (O_2), thus inducing loss of consciousness in the birds. CO_2 is an acidic gas, causing the birds to experience some discomfort and stress before loss of consciousness if inhaled at high concentrations [6; 15]. In multi-phase CAS/CAK systems, the birds are first exposed to relatively low concentrations of CO_2 (<40%), which is less aversive, and only once the birds are unconscious are they exposed to higher concentrations (80%–90%). Higher CO_2 concentrations are sufficient to induce a deeper state of unconsciousness or death [1; 15]. In comparison to electrical stunning, one major advantage of CAS/CAK is that uncrating and shackling of live poultry can be completely eliminated, hence avoiding pre-slaughter handling-induced fear, anxiety, distress, suffering and pain in conscious birds [7; 16].

Low atmospheric pressure stunning (LAPS) kills birds with a slow, continuous, controlled decompression causing a gradual reduction of O_2 availability, leading to progressive hypoxia [17; 18]. When O_2 concentration reaches low levels (less than 7%), birds may experience some level of aversion before becoming unconscious for about 30 seconds [19]. However, stunning with low atmospheric pressure and nitrogen is less aversive to chickens than CO_2 exposure [20]. The major welfare benefits of LAPS over electrical stunning systems are similar to CAS/CAK: there is no handling of live birds and no live shackling (since the birds are stunned in the modules used to transport them), no risk of pre-shocks, and no risk of ineffective stunning as LAPS reliably and irreversibly stuns all the birds [17; 21]. Additionally, LAPS does not use any gases during the stunning process and thus may be safer for human workers [22] and less aversive to the animals. Gas supply shortages, which sometimes affect CAS/CAK operations, are also not a concern for LAPS systems [23].

Finally, some chickens in the US are slaughtered without stunning. While the Humane Slaughter Act [24] dic-

tates all animals must be stunned before slaughter, some exemptions are allowed for religious practices. In particular, slaughter in accordance with the ritual requirements of any religious faith that prescribes a method of slaughter in which "the animal suffers loss of consciousness by anemia of the brain caused by the simultaneous and instantaneous severance of the carotid arteries with a sharp instrument" are exempt from the stunning requirement. While shechita (kosher slaughter) is carried out without stunning [25], low-voltage and high-frequency electrical stunning is commonly practiced in halal slaughtering of poultry requiring high throughput rates in the US [26; 27]. As birds must be alive at the time of their throats being cut, it means that the birds may be stunned to become unconscious as long as they are not killed before slaughter.

Researchers at the United States Department of Agriculture (USDA) reported that in 1991, 45,081,000 (0.8% of total) broiler chickens were slaughtered under religious practices without stunning, by severing the carotid arteries or by decapitation in the US. The same study showed that more than 99% of broiler chickens were subjected to electrical stunning[1], and none were subjected to CAS/CAK [28]. However, there is no current data on the prevalence of different stunning methods in US commercial chicken slaughter facilities. The prevalence of different chicken stunning methods is of current interest as animal advocacy groups, including The Humane League, The Humane Society of the United States and Compassion in World Farming are lobbying for adoption of better welfare standards in chicken production and improved stunning systems like CAS [29]. Thus, our goal in this study is to update the results of Heath *et al.* and provide contemporary estimates of the number of chickens in the US slaughtered using CAS, LAPS, electrical stunning and no stunning at all in 2019.

2. METHODS

To identify the chicken producers and the slaughter facilities with CAS/CAK and LAPS systems installed, we systematically searched media publications (producers websites, agricultural newsletters, etc.) for specific keywords ("slaughter plant", "gas stunning", "carbon dioxide", "controlled atmosphere stunning", "low atmosphere pressure stunning"). To find the number of animals slaughtered in each facility we searched media publications and the WattAgg producer database [30]. Of the 14 slaughter facilities identified as using CAS/CAK, we were unable to obtain processing capacity estimates for four facilities. For two such facilities, we estimated this number using the annual slaughter capacity of the particular company, divided by the number of slaughter facilities it operates. For the third facility, the slaughter capacity of another of the company's CAS facilities was known, and we used the same weekly slaughter number for the unknown facility. The fourth facility was relatively small (slaughtering less than 100,000 chickens, cows and pigs annually) and would not have a sizable impact on our final estimates. Thus we did not estimate its slaughter capacity. To estimate the number of chickens processed using electrical stunning, we subtracted the percentage of chickens stunned with CAS/CAK, LAPS and religious slaughter from 100%.

Since the supporting data was not collected directly from the facilities themselves, we used several approaches to validate our findings. First, we compared the weekly slaughter numbers we obtained against the slaughter volume category, as reported by the USDA, for each CAS/CAK and LAPS facility to find any discrepancies. We found no discrepancies, corroborating our results. Second, we checked the list of CAS facilities generated with our method against a list maintained by a non-profit monitoring chicken slaughter based on USDA reports. This validation also found no discrepancies. Third, we compared our estimate of the percentage of chicken slaughter facilities using CAS (5.5%) with an estimate provided by the National Chicken Council in 2019 (5%) and found no major discrepancy [31]. Fourth, we compared our estimate of the prevalence of electrical stunning (92%) with an estimate from the Animal Welfare Institute (more than 90%) and again found compatible estimates [32].

3. RESULTS

In 2019, there were 254 federally inspected chicken slaughter facilities operating in the US, representing 99% of chicken slaughter in the United States [33]. At the beginning of 2019, twelve broiler processing companies were using CAS/CAK, in fourteen chicken slaughter plants representing about 5.5% of plants. One of those facilities was closed in August, therefore at the end of 2019, thirteen slaughter plants had CAS/CAK systems

[1] Heath et al. estimated the prevalence of electric water-bath stunning in the paper as 92%; however according to the numbers given in Table 2, the correct percentage is 99% (= 5, 668, 025, 000/5, 713, 106, 000).

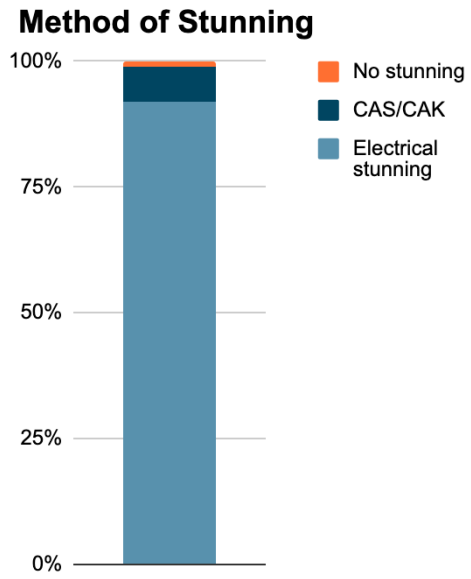

Figure 1 Prevalence of stunning methods among broiler chickens slaughtered in the United States in 2019.

installed. All but one of these facilities slaughtered at least 10,000,000 animals annually. In 2019, 9,224,243,000 chickens were slaughtered [33] and 691,184,000 were slaughtered using CAS/CAK. Thus about 7% of chickens were slaughtered using in CAS/CAK in the US in 2019. Although two slaughter facilities had used LAPS in the past, we found no facilities using LAPS in 2019.

Heath et al reported that in 1991, 0.8% of broilers in the US were slaughtered without stunning and/or by decapitation using religious methods. We could not find current data regarding the number of chickens slaughtered without stunning. However, since most of this slaughter is likely via shechita and the share of the US adult population identifying as Jewish appears fairly constant in the past two decades, it is reasonable to posit that this rate has remained fixed at about 1% [34]. With all other stunning methods accounted for, we estimate the remaining 92% of chicken slaughter uses electrical stunning. All supporting raw data are available at https://osf.io/u8ge3/.

4. CONCLUSIONS

This study provides current data on the percentage of chickens slaughtered with different stunning systems in the US in 2019. While our study relied on publicly reported data, rather than collecting data directly from producers, the validity of our results is corroborated by several other sources. However, our knowledge of the prevalence of religious slaughter methods without stunning in the US remains uncertain. This limitation could result in an overestimate of the prevalence of electrical stunning, although it's likely this overestimate is small, on the order of a few percentage points. Future research might seek to improve on these estimates by more precisely estimating the prevalence of slaughter without stunning and disaggregating CAS (stun-only) and CAK (stun-kill) systems.

As Heath et al. found no chicken CAS/CAK facilities in the US in their 1991 survey, the increased prevalence of CAS/CAK we found in 2019 represents an important improvement in chicken welfare at slaughter. These numbers will likely continue to increase as more chicken processing companies adopt CAS/CAK as a method of stunning in their slaughter facilities. Although these figures represent an improvement, the US still lags far behind other countries, like England and Wales where 70% of broilers were gas stunned in 2018 [35]. Improving slaughter conditions using multi-phase CAS/CAK is an essential step in improving chicken welfare at slaughter. While an increase from 0% to 7% over the course of 28 years represents only incremental progress, efforts by advocates might accelerate this change and benefit the billions of chickens farmed for meat production every year in the US.

5. CONFLICTS OF INTEREST

The Humane League Labs (THLL) performs scientific research to inform animal advocacy strategy. THLL is a program of The Humane League (THL), a 501(c)(3) nonprofit organization that "exists to end the abuse of animals raised for food." THLL is editorially independent from THL, and any other funders, in reporting research results. The design, execution, analysis, interpretation, and reporting of THLL research is performed entirely by THLL staff, without oversight by other THL staff or leadership. To further mitigate potential conflicts of interest, THLL demonstrates commitment to transparency by adhering to open science practices, including public preregistration of studies and analysis plans as well as publication of supporting data, computer code, and materials for all THLL research.

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