Force Feeding: An Examination of Available Scientific Evidence

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The debate over foie gras has been marked by much emotion. Opponents of foie gras refer mainly to personal feelings and observations rather than from experimental approaches. Opponents generally assert that the "cruelty" is quite obvious and there is, therefore, no need for scientific investigation. In an effort to answer factually questions about the science of foie gras production on geese and ducks, French researchers, particularly from the National Institute of Agronomic Research in Nouzilly, France, have conducted numerous studies to objectively gauge the actual impact of foie gras production on animals and to scientifically assess the claims of foie gras opponents.

In this paper, we explore the hard science as it relates to three broad allegations made by opponents of foie gras. First, our paper will focus on scientific studies conducted into the occurrence of stress in ducks and geese and whether foie gras farming is "cruel" as opponents assert. Second, we will examine the pathological state of the livers produced. Third, we explore research done into whether or not foie gras is or is not "natural."

I. Scientific Examination of Stress, Pain and Fear Levels in Force-Fed Ducks

While so much of the debate over foie gras has focused on how the force-feeding affects the birds involved, there has been relatively little examination of the available empirical scientific studies conducted. There does exist substantial data regarding whether and to what extent feeding techniques create stress, pain and fear in farmed waterfowl.

A. Does Force-Feeding Cause Stress?

The concept of stress refers to a challenge imposed by environmental factors to the regulatory systems of any organism in order to adapt to the new situation. This response involves several biological systems and emotional components. Stress may result in a permanent negative outcome, or it may involve energy expenditure in order to reach a new homeostatic status. When the stressing agent is sudden and does not last, one refers to acute stress. Chronic stress, on the other hand, refers to a lasting challenge. The main physiological indicators of stress are the modifications in corticosterone levels and changes in heart rate and arterial blood pressure, which are related to autonomic nervous system activation.

Stress levels in birds can be gauged through the measurement of corticosterone blood levels. (Faure *et al*., 1998, Guémené *et al*., 1998; 2001; 2006). The production of foie gras implies force-feeding, which requires placing a tubing in the esophagus in order to introduce a large amount of food in a few seconds, 2 or 3 times a day during a two to four week period, depending upon the species and procedure. In designing a study to measure stress induced by force-feeding, our research team developed a hypothesis that this practice could be at the origin of both acute and, due to its repetitive nature over time, chronic stress.

Clinical experimentation has shown that force-feeding does not induce any significant increase in plasma corticosterone levels in ducks kept in individual cages. In addition,

additional experiments have demonstrated that the corticotrope system remains fully functional during the force-feeding period. The ducks were still able to secrete corticosterone after a physical stress such as 15 minutes constrained in a net, demonstrating that the physiological status induced by overfeeding did not result in a blunted responsiveness of the alarm system (Guémené *et al.,* 1998; 2001). In measuring corticosterone levels of ducks kept in group pens, clinical study showed no significant increase in stress levels except after the first instance of force-feeding and strongly suggested that increased stress measurements resulted from holding the ducks rather than from the actual force-feeding.

A similar conclusion regarding the absence of stress perception was drawn after recording the heart rate, as no acceleration was detected when the tubing was introduced in the esophagus (Serviere *et al.,* 2002). Although, it was not our initial experimental hypothesis, our research concluded that force-feeding is not perceived as a major source of acute or chronic stress by the waterfowls.

B. Assessing Claims that Force-feeding Induces Pain

The presence of pain in animals may be difficult to measure scientifically because animals can only express themselves through behavior. Neuroscience, however, provides information about the nervous system that can help us to assess the incidence of pain. Experiments involving the visceral nervous system, which computes sensory and motor information from organs including the digestive tract and related secretary glands, have been carried out to assess potential signs of pain in ducks at different stages of the force-feeding period (Servière *et al.,* 2002).

Neural activation indicating the presence of pain signals were never detected in the sensory visceral brain centers of force-fed ducks (Servière *et al*., 2003). Although there is a need for further scientific investigations, the data provided do not demonstrate the presence of major pain-induced signs in the nervous system of force-fed mule ducks.

This absence of pain indicators likely results from anatomical specificity of the waterfowl involved in foie gras production. For example, ducks and geese, like many other bird species, are able to swallow large preys. Consequently, the inside diameter of the upper part of the esophagus, which is essentially an expandable elongated pouch in waterfowl, the pseudo-crop sac, is comparatively larger than in mammals and is not circled by cartilaginous rings, explaining the capacity to swallow large objects. Its volume ranges from 600 to 800cm^3 in mule ducks (Guy), while it is reported to be smaller in geese (below 500 cm^3) (Leprettre *et al*., 2002). For this reason, each meal with geese will have a smaller volume than with mule ducks, though the number of daily meals with geese will be higher. In addition, this pouch is located at the level of the neck (25-35cm long) allowing full expansion under the elastic skin of the neck, without any compression of the organs present in the thoracic cavity. It also allows the birds to potentially absorb large amounts of food, which is stored there before being progressively released. The pseudo-crop sac membrane is covered with keratin, which provides a mechanical resistance capacity much higher than the epithelium of most mammals. Another specificity resides in the fact that the opening of the trachea sits in the middle of the tongue. Thanks to the collapsing action of tongue muscles since this anatomical feature allows ducks to eat and absorb water under the water without drowning. This specificity explains why, as long as the procedure is carried under proper conditions, ducks do not have the upper respiratory tract blocked by the force fed meal, a criticism which is often raised by opponents.

Some criticisms of foie gras relate to the occurrence of bumblefoot as a consequence of inappropriate rearing conditions. The problem of bumblefoot is not specific to animals

kept in cages, but also to those kept in floor pens. The condition appears more prevalent when birds have access to outside free-range and is generally associated with poor litter quality, especially humidity.

Panting in ducks, which frequency is increased by the end of force-feeding period (Guémené *et al*., 2006), strikes many visitors of a force-feeding operation and is often misinterpreted as an indicator of discomfort. Panting originates from a thermo-regulatory reflex. Birds have no sudoriferous glands and their capacity to eliminate extra heat through contact with the air is limited by the insulating properties of their plumage. Thus, they open their beaks and pant to eliminate the latent heat associated with water losses. Panting constitutes an effective way "to burn" excessive calories. It is neither a voluntary nor deliberate action but a reflex controlled by the respiratory bulbous centers.

Globally, in absence of wound or pathology, force-feeding does not appear to induce pain and is not a major source of nociceptive information integrated by the nervous system.

C. Are Ducks and Geese Frightened by the Force-Feeder and/or Force-Feeding?

Aversion to force-feeding and force-feeders has been left too often to anecdote rather than scientific measure. Breeders like to recall the anecdote in which free waterfowl spontaneously run up to receive their ration by force-feeding, while detractors that birds present an aversion to the force feeder and\or to force-feeding.

To test this possibility of aversion, behavioral tests were conducted using the accepted hypothesis that an avoidance response should be observed only if stimuli associated with the situation, are aversive. The behavioral responses of geese and ducks, which were previously trained to move from their rearing pen to a feeding pen in order to have access to their food, have been studied. After a training period, half of the birds were force-fed, and the amount of food ingested was adjusted to equal the amount spontaneously ingested by the non-force-fed control birds. During the experimental period, force-fed geese continued to move spontaneously and at the same speed as the control group (Guémené *et al*., 1998; 1999; Faure *et al.,* 2001). In mule ducks, the response was more ambiguous. Generally, mule ducks are fearful, social and very sensitive to any environmental factors (*e.g.*, change of the experimenter or in the timetable) that will affect behavioral responses. Additional experimentation, however, demonstrated that the flight distance of ducks was higher in front of an unknown person than with the caretaker who performed force-feeding daily (Faure *et al.,* 2001). Empirical observations with geese delivered similar results. Furthermore, there was no development of aversion to the operator throughout the force-feeding period. In fact, the flight distance lessened with time. Moreover, familiarization limited the amplitude of the physiological responses to physical stress (Guémené *et al.,* 2002; Servière *et al.,* 2003), as well as behavioral reactions of fear in specific experimental tests (Guémené *et al.,* 2002; 2006).

In conclusion, force-fed ducks or geese do not develop any avoidance behavior towards the force-feeder and the force-feeding context. Additionally, familiarization with the feeder appears to have beneficial smoothing effects, both on behavioral and physiological responses.

II. Claims that Foie Gras is Diseased Liver Are Unsupported by Research

Opponents of foie gras production have often claimed that hepatic steatosis, also referred as lipidosis, is a pathological condition. While this statement is true in mammals,

including humans, it is not the case in birds. To equate a human pathology with that of certain migratory waterfowl disregards obvious physiological differences between the species.

A. Human Steatosis Is Different than Steatosis in Mule Ducks and Other Waterfowl

In humans, hepatic steatosis occurs as a response to various forms of inherited or acquired metabolic disorders (Alpers *et al.*, 1993). Human steatosis is most frequently secondary to alcoholic intoxication (cirrhoses) and is not reversible over a certain stage. Another type of steatosis, which is increasing among Western human populations, occurs in patients exhibiting metabolic syndromes such as overeating, obesity, dys-lipidemia and insulin resistance. In some patients, this fatty liver remains isolated, has no clinical consequences and does not cause any pain. In others it may evolve into Non-Alcoholic Steatohepatitis (NASH) after several years (Day & James, 1998).

There are some species, however, in which the metabolic adaptations naturally result in hepatic steatosis. These include wild migrating birds and fish (*e.g.*, cod), in which moderate hepatic steatosis occurs spontaneously as a consequence of energy storage before migration (Pilo and George, 1983). The process of hepatic steatosis is facilitated in these oviparous species, because the liver is the major site of de novo lipogenesis, which is not the case in mammals. In chicken, 90% of the *de novo* lipogenesis synthesis is insured by the liver. This number reaches has high as 96% in pigeons. Humans, by contrast, reach a maximum of 30% after eating (Timlin and Parks, 2005).

In domestic waterfowls, this specific capacity of large liver fat storage is exploited for foie gras production in a proportion not observed under natural conditions. In the goose, the liver weight can increase 10 fold in two weeks and account for 10% of the body (Hermier *et al*., 1994). In mule ducks, the average liver weight at the end of force-feeding was around 550g in 2002 in France (Chalimbaud, 2004). Their genetic potential, however, would allow the liver to reach a weight of over 800g.

Examination of foie gras demonstrates the absence of disease. Foie gras represents a quasi-pure form of acquired hepatic steatosis of nutritional origin. The tissue is not diseased, as degenerative events such as necrosis or cirrhosis never occur. The hepatic cells preserve their integrity and continue to perform their function. Were this not the case, the animals would not survive force-feeding, even over a time as short as the two weeks (Benard and Labie, 1998). Unlike human fatty liver, foie gras does not exhibit any macroscopic lesions.

Additional indicia also prove an absence of pathological conditions in foie gras. Lipids, for example, store differently in steatosis that is of pathological rather than nutritional origin. In pathological steatosis, one would expect to see centrolobular lipid accumulation, which is not observed in foie gras production (Benard *et al*., 2005). Furthermore, although the conjunctive hepatic substrate of cells is bloated in foie gras producing ducks, the capsule around the liver remains uninjured.

B. Reversibility of Steatosis and Impact on Liver Function in Foie Gras Production

Very important, is the fact that the steatosis in foie gras is fully reversible. After leaving the animal free to feed, there is a three to four day spontaneous fasting, and the liver

returns to its initial composition within two weeks when over feeding is interrupted. This process has been demonstrated to be true both in geese and ducks, and it is true even after repeated periods of force-feeding and fasting (Babile *et al.,* 1998; Benard *et al.,* 1998). This method was originally used for selection purposes and had no negative consequence on the future reproducers.

In addition to the data related to liver function, several studies demonstrate that the whole regulatory system of glucose and insulin remains in working physiological condition, despite the force-feeding. This is a new set of data that can be interpreted to demonstrate the preservation of the functional status of hepatic cells during the period of force-feeding. It has been established that blood glucose concentration is regulated within a narrow range by pancreatic hormones, in particular by insulin. Insulin exerts a stabilizing action upon glycemia and allows the entrance of glucose into target tissues (liver, adipose cells, muscles) to be stored as glycogen or fatty acids. In mammals, lasting excessive food intake, with large amounts of carbohydrates, can unbalance this equilibrium and lead to obesity and diabetes (James and Day, 1998). In mule ducks, recent scientific studies (Berradi *et al*., 2003; Davail *et al*., 2003) do not demonstrate any rise in insulin level nor any progressive increase of blood glucose level throughout the force-feeding period. As neither insulin function nor glucose/insulin equilibrium are altered, it implies that physiological regulatory mechanisms remain functional in force-fed birds.

C. Mortality Rates of Birds In Foie Gras Production Indicate an Absence of "Disease"

Opponents of foie gras have often alleged that force-feeding practices result in high mortality rates. Data from experimental approaches do not support this conclusion, and field data provides only an overall culling index below 3% in recent years (Chalimbaud, 2004). Culling causes include not only mortality but also other conditions such as wounds, weakness, injuries at transfer, etc. The recently observed decrease in the culling index has been associated with changes in rearing conditions and feeding techniques.

III. A Review of the Scientific Studies Regarding Whether Foie Gras is "Natural"

At first blush, some may not consider foie gras production to be "natural." Upon further consideration, however, the conclusion is much less obvious. If by "natural" one intends to an agricultural process in which humans do not interfere with the production process, then the whole process of plant and animal agriculture can be called into question as "unnatural." Agriculture has always been about selective breeding to produce plants and animals not previously known in nature. Additionally, for millennia, farmers have sought farming techniques to increase both crop and animal agriculture yields.

A. Is it "Natural" for Migratory Waterfowl to Over-Feed?

For some, this question of what is "natural" centers around the notion that wild species do not over-feed themselves nor do they produce livers similar to foie gras. In fact, many migrating species do express a spontaneous capacity to over-feed and accumulate fat deposits in muscles, adipose tissues and, to some extent, in liver at distinctive periods along the seasonal cycles. This is particularly the case in periods requiring a great deal of energy consumption, such as the migration. Some opponents of foie gras contend that, despite this natural tendency of migratory waterfowl to over-feed, force-feeding in foie gras production

involves the ingestion of amounts of food that are greatly in excess of the birds' ability to spontaneously absorb. Critical to a scientific examination of this charge is a factual understanding of the quantities of food ingested and a clear understanding of the inappropriateness of a comparison between human and duck ingestion capacity.

Through our scientific studies, we have observed that a single mule duck can ingest, without any physical constraint, up to 500g (over 1 pound) in a single meal and over 750g of food during a day (Guy *et al.,* 1998). Similarly, "Landaise" Grey geese have been reported to spontaneously graze 1kg of pasture daily, while also being fed a regular diet (Leprettre *et al*., 2000). These geese can also eat as much as 3kg of carrots daily.

The quantity of food fed to mule ducks and geese fits well within this range of spontaneous ingestion capacity. Force-feeding techniques used by farmers involve gradually increasing the amount of feed given to the birds over the course of two to four weeks. The maximum quantities of food are provided toward the end of the force-feeding period and never exceed 1000g daily, or 500g per meal.

B. Impact of Modern Breeding Methods on Foie Gras Production

Claims that foie gras is not "natural" may also be based on the fact that the species generally used in modern foie gras production, the mule duck, is an "artificial" cross between a female Pekin and a male Muscovy duck, obtained by artificial insemination, to create a genotype not present in the wild. The process of genotype selection and intercrossed species is as old as the history of domestication itself. Horses have been bred with donkeys to produce mules, for example. In the present situation, the producers have taken advantage of the capacity of some genotypes to optimally respond to force-feeding by a large and rapid increase in lipid synthesis and storage in the liver without signs of pathology or morbidity. It is worth noting that neither the Polish geese nor the Pekin ducks respond as the Landaise geese and the mule duck do to force feeding. Modern hybrids used for foie gras production are thus specifically adapted for this type of production.

Conclusion

Our objective has been to provide objective experimental data to a debate that has, heretofore, been dominated by emotion. Our data have been published in both national and international peer-reviewed scientific journals. Our years of study have led us to conclude that the scientific data do not support the statement written in the report from the European Veterinary Scientific Committee (1998) that *" [t]he scientific committee on animal health and animal welfare concludes that force feeding, as currently practiced, is detrimental to the welfare of the birds.*" That statement, while clearly taken for granted by opponents of foie gras, was based on the very limited amount of scientific literature available at the time and is not supported by the extensive scientific experimentation done in the intervening years.

The references quoted in the text are available on request.