

Knock out the pain genes

It might be possible to reduce suffering in farm animals by manipulating their biology

Ewen Callaway

WITH “hormone-free”, “cage-free” and “antibiotic-free” becoming common labels on our supermarket shelves, might “pain-free” be the next sticker slapped onto a rump roast?

As unlikely as that may seem, progress in neuroscience and genetics in recent years makes it a very real possibility. In fact, according to one philosopher, we have an ethical duty to consider the option.

“If we can’t do away with factory farming, we should at least take steps to minimise the amount of suffering that is caused,” says Adam Shriver, a philosopher

“I’m offering a solution where you could still eat meat but avoid animal suffering”

at Washington University in St Louis, Missouri. In a provocative paper published this month, Shriver contends that genetically engineered pain-free animals are the most acceptable alternative (*Neuroethics*, DOI: 10.1007/s12152-009-9048-6). “I’m offering a solution where you could still eat meat but avoid animal suffering.”

Humans consume nearly 300 million tonnes of meat each year. Our appetite for flesh has risen by 50 per cent since the 1960s, and the trend looks set to continue. Most of this will likely come from factory farms, notorious for cramped quarters and ill treatment of animals. Battery farm chickens, for instance, routinely have part of their beaks

removed without anaesthetic or pain relief to prevent them from pecking their neighbours.

Progress in understanding and manipulating the molecular and genetic bases for pain means ethics and economics, not technical feasibility, may end up determining whether Shriver’s proposal becomes a reality.

For instance, mice lacking a gene called *Nav1.7* are less sensitive than normal rodents to heat and pressure (*Proceedings of the National Academy of Sciences*, vol 101, p 12706). By similarly blocking the sensation of pain in livestock, practices like debeaking would potentially be “much more humane”, says Shriver.

One objection to the idea of knocking out pain in livestock is that it could mean they put themselves in harm’s way. In 2006, researchers identified six children from three Pakistani families with mutations that inactivated one particular gene. None of the children had ever felt pain, though they appeared otherwise healthy. All the kids had bruises and cuts, and one, who was known to place knives through his hand and walk on coals, died after jumping off a roof (*Nature*, vol 444, p 894).

There could be a way around that problem. Recent research indicates that the sensation of pain is distinct from the unpleasantness, or “affective pain”, connected with it. This suggests it might be possible to eliminate the suffering caused by pain without tampering with the physical sensation.

“We know that you can dissociate the sensation from how



ALESSANDRA SANGUINETTI / MAGNUM

much it bothers you,” says Martha Farah, a cognitive neuroscientist at the University of Pennsylvania in Philadelphia. For instance, people on morphine feel pain, but are less troubled by it than they would be without the drug.

Studies have linked affective pain in humans to neurons in a region of the brain called the anterior cingulate cortex. Some people with lesions in this area can sense pain but don’t describe it as unpleasant. Surgeons occasionally excise portions of the ACC to rid patients of debilitating chronic pain.

It’s impossible to know how animals such as cows, pigs and rodents feel about pain, but “it seems plausible that the ACC is playing a similar role”, Shriver says.

A recent study showed that rats with ACC damage behaved as though they were less affected by pain. They would recoil in response to an electric shock, but given the choice between staying in the dark – which rats prefer – and avoiding shocks in a lighter chamber, rats with ACC lesions opted for shocks (*Experimental Neurology*, vol 197, p 22).

Performing brain surgery

In this section

- Geoengineering gets real, page 10
- Scientific insight on torture, page 14
- Human genes evolved from nowhere, page 15



Would you rather eat a pain-free steak?

on livestock wouldn't be feasible on an industrial scale. Livestock would have to be genetically engineered to be pain-free for it to be profitable.

Zhou-Feng Chen, a neuroscientist at Washington University in St Louis and colleagues are identifying the genes that regulate affective pain. Already, they have engineered mice that lack two enzymes which help neuron-to-neuron communication in the ACC. When the team injected a noxious, painful chemical into their paws, the mice licked them

only briefly. In contrast, normal mice continued to do so for hours afterwards (*Neuron*, vol 36, p 713). This suggests that livestock could be spared persistent, nagging pain.

Other work in Chen's lab suggests genetic engineering may do an even better job at tempering affective pain. Last year, the team identified a gene expressed almost exclusively in the ACC called *P311*. Mice without *P311*

"We know that you can dissociate the sensation of pain from how much it bothers you"

FROM PETRI DISH TO DINNER PLATE

If the prospect of pain-free animals leaves a nasty taste in your mouth, there may be another way of being an ethical carnivore.

"Some people are working on producing meat at the cellular level and that just seems a better option to me, if it can be done," says Peter Singer, a philosopher and vegetarian at Princeton University.

In vitro meat isn't ready for dinner plates just yet. Researchers are making progress growing animal muscle cells that could be used in processed meats such as chicken nuggets or fish sticks. But intact muscles require blood vessels and connective tissue as well, and progress growing those is slow

(*Tissue Engineering*, vol 11, p 659).

"The real challenge, and the reason why the technology is not taking off, is cost and scalability," says Vladimir Mironov, a tissue engineer at the Medical University of South Carolina in Charleston. Lab-grown animal cells live off costly nutrients, growth factors, proteins and hormones, and commercial bioreactors are not designed to produce meat on an industrial scale and are too expensive to make it profitable.

That could change. A report last year by the In Vitro Meat Consortium contended that prices could eventually fall below €3500 per tonne, making in vitro meat competitive with the real thing.

recoiled from heat and pressure. But when the team taught their mice to associate a region of their cage with a painful formalin injection, normal mice rapidly learned to avoid that area, while those lacking *P311* kept returning.

Since *P311* varies little among mammals, it's possible that knocking out the gene in cows and pigs could yield comparable results, Chen says.

Peter Singer, a Princeton University philosopher who has argued that animal suffering should be balanced against the benefits of eating meat, says that his would be a moot objection if pain-free livestock could be engineered. But he argues that this on its own would not make intensive livestock farming OK: cruelty, he points out, is hardly the industry's only flaw.

"Large farms have become an environmental disaster," agrees Alan Goldberg at Johns Hopkins University in Baltimore, Maryland. They generate enormous amounts of waste and greenhouse gases and breed antibiotic resistance. "I think factory farms have to go, it's that simple."

Goldberg also contends that public attitudes may make pain-free livestock a non-starter. He

and colleague Renee Gardner conducted an online survey on the use of pain-free animals in research and found little public support, even among researchers who experiment on animals (*Alternatives to Animal Testing and Experimentation*, vol 14, p 145).

"The experience of pain is but one reason not to harm animals," says Marc Bekoff, an ethologist at the University of Colorado in Boulder. "The fact that they are alive, even if not sentient, warrants against using them in ways that result in their death."

Concerns over genetically modified meat could also scuttle plans to knock out pain in livestock. Although the US Food and Drug Administration recently opened up the possibility of putting cloned and genetically engineered meat on the market, consumer groups are wary and some companies have vowed to keep it out of the food system.

Shriver, a long-time vegetarian, has sympathy for his critics' views. Certainly, eliminating factory farms would be the best option, he says, adding: if someone can prove that we really are on the verge of moving to that kind of society, "then I would be happy to jettison my idea". ■