Vitenskapskomiteen for mattrygghet
Norwegian Scientific Committee for Food Safety

Opinion of the Scientific Panel on Animal Health and Welfare of the Norwegian Scientific Committee for Food Safety related to the ability of the foetus to sense or feel discomfort, pain and stress.

Summary of Opinion:

The Norwegian Scientific Committee for Food Safety was asked by The Norwegian Food Safety Authority to produce an opinion on the ability of the foetus to sense or feel discomfort pain and stress.

A Scientific Report on these topics was made for the Panel by Dr. J.L. Lyche, the Norwegian School of Veterinary Science and Dr. A.M. Janczak, MSc M.S. Eriksen and Professor B.O. Braastad, the Norwegian University of Life Sciences. The Scientific Report can be found at **http://vkm.no/dav/9b444f9f25.pdf**
Also, the document "Effects of gestational exposure to toxic compounds and stressors on embryos, foetuses and offspring" produced by the Panel chairperson, Professor Wenche Farstad, for the meeting of the Panel in Bergen on November 4th-5th 2004, was considered when the final assessment was made. This report is also published on the website.

The Scientific Panel of Animal Health and Welfare focuses on the assumption that theoretically, in humans, pain perception becomes possible at about the beginning of the last trimester. This is probably also valid for other mammalian species. There may, however, be important species differences, since the maturity of mammalian foetuses in late gestation vary considerably.

Even though the anatomical and physiological systems for pain sensation and perception are fully developed in late gestation, the foetus may not be able to feel pain because it appears to be unaware until after birth. A strong evidence for this is that normal oxygen levels in the circulation of the foetal lamb are below the concentrations required to support awareness in neonates and adults. However, since it is not known what level of oxygen is able to induce some degree of consciousness in late term foetuses, the use of pain relief may be considered as a precautionary principle if major invasive techniques are to be used on foetuses in late gestation.

The Scientific Panel considers that prenatal stress can impair the stress-coping ability of juvenile and adult offspring of fish, birds and mammals and disrupt their behaviour in aversive or conflict-inducing situations. Similar effects may result from exposure of sublethal or smaller doses of toxic substances during foetal life. It may be predicted that farm animals, fish and birds subjected to prenatal stress or some toxic compounds are at risk of showing reduced ability to cope with a difficult environment. This may lead to increased or prolonged stress responses and an increased propensity for developing behavioural disturbances which may compromise their welfare. These negative effects to stress exposure during gestation should be considered when handling pregnant animals and when designing the environment for aquaculture and egg production systems.

Background:

As a consequence of the Report to the Norwegian Parliament on Animal Keeping and Animal Welfare, “St. melding nr. 12 (2002-2003)”, a working group was established by the Government to work out a proposal for the elaboration of a new revised Animal Welfare Act. In relation to this work, the Norwegian Food Safety Authority needed to examine new animal welfare aspects and determine if new groups of animals should be protected under the Act. As part of this procedure, the ability of foetus to sense or feel discomfort, pain and stress, including postnatal effects, needed further elucidation.

The Norwegian Scientific Committee for Food Safety was requested by The Norwegian Food Safety Authority to give an opinion on these topics on the 24th of October 2004. The Scientific Panel on Animal Health and Animal Welfare asked the Norwegian School of Veterinary Science to produce a scientific report on the topics as a background-document for

the assessment. The discussions and conclusions of the panel are, to a large extent, based on the Scientific Report, published on the VKM web site http://vkm.no/dav/9b444f9f25.pdf

Terms of reference:

The Norwegian Scientific Committee for Food Safety was requested by the Norwegian Food Safety Authority to assess the ability of the foetus to sense or feel discomfort, pain and stress. The assessment was to include species of mammalian foetus, in particular the foetus of ewe, cow and pig and the foetus of birds, with particular emphasis on egg laying hens (*Gallus gallus*). The assessment was also to include the ability to experience pain in the foetus if the mother is killed, in situations where the foetus subsequently dies and, in addition, the foetus' feeling of pain and stress if the mother is intoxicated.

Finally, the assessment should consider postnatal effects of prenatal stress on behaviour, physiology and morphology of offspring from mammals, birds and fish.

Assessment:

Pain pathways and cortical and subcortical centres involved in pain perception are well developed in late gestation. Moreover, the neurochemical systems associated with pain transmission are intact and functional. Theoretically, in humans, pain perception becomes possible at about the beginning of the last trimester. This may also be valid for other mammalian species, such as some domesticated farm- and laboratory animals. There may be important species differences since the physiological maturity of mammalian foetuses in late gestation varies considerably between species. Even though the anatomical and physiological systems for pain sensation and perception are fully developed in late gestation, the foetus may not be able to feel pain because it appears to be unaware until after birth. A strong evidence for this hypothesis is that normal levels of O_2 in the circulation of the foetal lamb are below the concentrations required to support awareness in neonates and adults. However, since the foetus is conditioned to lower levels of oxygen tension than neonates and adults, it is not known if those lower levels may be sufficient to allow a degree of consciousness in foetuses. Research on the effect of analgesia on the foetal stress response to noxious stimuli is particularly important in this context. Hence, the use of pain relief may be considered as a precautionary principle if major invasive techniques are to be used on foetuses in late gestation.

The assessment was also to include the foetus` experience of pain when the mother is killed in situations when the foetus subsequently dies and, in addition, the foetus feeling of pain and

stress when the mother is poisoned. When the dam is slaughtered, asphyxia occurs in the foetus due to rapid decline in blood pressure and subsequent circulation failure when the dam is killed by immediate bleeding after stunning. In domestic animals that are slaughtered commercially, it cannot be excluded that this may elicit stress response in the foetus when the dam is killed in later stages of pregnancy if the bleeding process is delayed or prolonged after stunning. From the argument above on the significance of oxygen tension to awareness, however, it is unlikely that the foetus will be conscious and thus able to perceive pain when the killing of the dam is carried out correctly. The response of the foetus to poisoning of the dam may depend on the specific effect of the toxic compound, if the effect is lethal to the dam and how rapidly the dam is killed. From the report of Farstad (page 2) it is possible that doses of toxic compounds that do not kill the mother or the foetus (sublethal or smaller doses) may affect the foetus negatively during postnatal life. Some of these effects may be mediated through changes in the hypothalamus-pituitary-adrenocortical (HPA) axis.

The effects of prenatal stress on behaviour, physiology and morphology of offspring from mammals, birds and fish were described in the Scientific Report. Stress during pregnancy has for a long time been known to affect embryonic survival and mortality, and is therefore important with regard to reproduction in farm animals. In addition, evidence from animal and human studies shows that prenatal stress may produce permanent developmental changes, such as impairment of the stress-coping ability, disruption of behaviour in conflict-inducing situations and negative effects on reproductive success in the first, and sometimes also in the second, generation. Those effects may be related to increased or prolonged activity in the HPA axis produced by impaired negative feedback of glucocorticoids in the hippocampus, although several other neuroendocrine pathways may be involved. These potential long-term consequences of prenatal stress on the biological constitution of the offspring may impair their welfare. Hence, the influence of sublethal stress on the mother and foetus leading to postnatal effects on the behaviour of the offspring may be an unspecific response to stressors which is similar in nature to the effects of some toxic stimuli. These effects should be considered when handling pregnant animals.

Farmed fish are exposed to a wide range of temporary and chronic challenges during various phases in their life cycle, and the conditions to which fish-farm broodstock are subjected during sexual maturation might be a significant factor in determining the nature of gametes produced and the succeeding offspring characteristics. In teleost fish the maternal endocrine

system and that of the progeny is closely associated, and current evidence suggests that diverse developmental, reproductive and metabolic hormones are released into the nutritive yolk sac during oogenesis in quantities that reflect female plasma levels. Evidences prove that mothers with increased plasma cortisol levels produce alevins that are smaller and have reduced yolk sac size. Increased plasma cortisol level can also impair the ability of progeny to cope with an environmental challenge. This is reflected by increased offspring mortality, reduced alevin length and body weight, diminished yolk sac volume and decelerated yolk sac utilization. It is also shown that increased levels of maternal cortisol may enhance the frequency of deformed offspring.

Stress in egg laying hens may affect the hormone content of their eggs and lead to prenatal stress also in birds.
Experiments on prenatal stress in hens indicate that chicks hatching from eggs with elevated levels of corticosterone have a reduced ability to learn or remember other individuals and objects, a reduced ability to cross barriers to access resources such as feed, a reduced ability to compete, an elevated fear of humans, elevated stress sensitivity and a reduced growth rate. It is also shown that prenatal environmental stress has effects on competitive ability and fear in hens.

Conclusions:

The Scientific Panel on Animal Health and Welfare focuses on the statements from the Scientific Report that theoretically, pain perception becomes possible at about the beginning of the last trimester. Even though the anatomical and physiological systems for pain sensation and perception are fully developed in late gestation, the foetus may not be able to feel pain because it appears to be unaware until after birth. A strong evidence for this is that normal oxygen levels in the circulation of the foetal lamb are below the concentrations required to support awareness in neonates and adults.

The argument of the significance of low oxygen tension is applicable in cases when the mother is killed in late pregnancy, indicating that rapid asphyxia precludes the ability of the foetus to sense pain. However, since the foetus is conditioned to lower levels of oxygen tension than neonates and adults, it is not known if those lower levels may be sufficient to allow a degree of consciousness in foetuses. Further research is therefore needed to elucidate

whether this is the case in all mammals. Research on the effects of analgesia on the foetal stress response to noxious stimuli is particularly important in this context. Until sufficient evidence has been assembled, the use of pain relief may be considered as a precautionary principle if major invasive techniques are to be used on foetuses in late gestation.

Prenatal stress can impair the stress-coping ability of juvenile and adult offspring of rodents and farm animals and disrupt their behaviour in aversive or conflict-inducing situations. Similar effects may result from exposure of sublethal or smaller doses of toxic substances during foetal life. It may be predicted that farm animals subjected to prenatal stress or some toxic compounds is at risk of showing reduced ability to cope with a difficult environment with increased or prolonged stress responses and have an increased propensity for developing behavioural disturbances. This may compromise their welfare. Hence, these effects should be considered when handling pregnant animals.

Since experiments have shown that stress also may have detrimental effects on progeny of fish, it substantiates the need for incorporation of possible maternal effects in aquaculture from a welfare point of view. Similarly, stress in egg laying hens may have a number of negative effects on welfare and productivity of chickens. Thus, it is important to improve the production system and early environment for both layers and chickens.

References:

All references are available in the Scientific Report “The ability of the foetus to sense discomfort, pain and stress”. In addition, Farstad W, 2004, “Effects of gestational exposure to toxic compounds and stressors on embryos, foetuses and offspring” was also used to produce the final evaluation.

Scientific panel members:

Wenche Farstad (chair), Knut E. Bøe (vice-chair), Bjarne O. Braastad, Kåre Fossum, Brit Hjeltnes, Tore Håstein, Jon-Erik Juell, Rune Waagbø.

Acknowledgements:

The Scientific Panel on Animal Health and Animal Welfare of the Norwegian Scientific Committee wishes to thank Dr. Jan L. Lyche, the Norwegian School of Veterinary Science

and Dr. Andrew M. Janczak, MSc Marit S. Eriksen and Professor Bjarne O. Braastad, the Norwegian University of Life Sciences for the preparation of the Scientific Report used as a basis for this Scientific Opinion. Dr. Jan L. Lyche is also acknowledged for the contribution to the discussion at the Panel`s meeting on the 24th of January 2005. The panel members Professor Wenche Farstad, the Norwegian School of Veterinary Science and Professor Bjarne O. Braastad, the Norwegian University of Life Sciences have also contributed to the Scientific Report with supplementary report, literature advice and comments to the manuscript.