

Subject: Misrepresentation of my research by David Henkin of Earth Justice in the Pa'ina Hawaii proceedings

I have recently been made aware of, that a private company seeks to build an irradiator near the Honolulu airport. The purpose of the irradiator is mainly to treat fruits to be exported to the US Mainland and to help prevent further infestation of alien species that will harm Hawaii's environment and further burden agriculture in the islands.

In October of 2005, David Henkin from Earth Justice filed a request for hearing with the US Nuclear Regulatory Commission (NRC) in the licensing proceeding of Pa'ina Hawaii, the irradiation company. Numerous contentions were raised, among them the allegation that irradiated food is unsafe to eat. Mr. Henkin claims that "special circumstances" exists for the raising of a radiation facility which will treat food for human consumption and wants the NRC not to approve the application of Pa'ina Hawaii. He relies in his comments strongly on the arguments of Dr. Au, an environmental toxicologist from the University of Texas. Dr. Au focuses in his declaration of Sept., 29, 2005 strongly on the formation of a recently-discovered unique class of radiolytic products that are generated on irradiation of fat-containing foods, namely the 2-alkylcyclobutanones (2-ACBs) and claims these compounds to be genotoxic and mutagenic. As one of the researchers on the topic of toxicity of 2-ACBs in irradiated fat-containing food I want to make a few comments which will make clear that Dr. Au is grossly overestimating the risk of eating irradiated papayas.

First of all, I am wondering that David Henkin has chosen Dr. Au as his witness since it is well-known that Dr. Au is not reliable as an expert in food irradiation. Already 2003, I pointed out that Dr. Au is greatly exaggerating the potential risks of food irradiation and does not stick to the scientific facts (Opinion on the Expert Affidavit on Safety Issues of Irradiated Food for School Children sworn by Dr. William Au with date of Dec. 10, 2002. My opinion was expressed on April 02, 2003, available still today in the internet http://www.mnbeef.org/opinion_on_the_expert_affidavit_.htm). At that time I accused Dr. Au of committing perjury, since he claimed that 2-ACBs are mutagenic although his claims were not substantiated by the literature he cited, which was in fact our work. Obviously, in 2002 Dr Au was not telling the truth and his affidavit was of no value. Mr. Henkin could have easily searched the internet to find out about Dr. Au's past as an expert witness. Since my name is quoted in his allegations, the least Mr. Henkin could have done is contact me to verify Dr. Au's testimony. Hiring an expert that is not telling the truth and thereby committing perjury is not becoming.

Exactly, this is the situation with Mr. Henkin's witness. Unfortunately, Dr Au has not learned anything in the mean-time, since he again in his present declaration of Sept. 29, 2005 testifies that 2-ACBs have been shown to be mutagenic (reference again to our work). He declares under penalty of perjury that he has read his own declaration and knows the contents thereof to be true of his own knowledge. In his declaration he mentions a recent article on health hazards from the consumption of irradiated food which he co-authored (Ashley et al., 2004). In this article it is correctly written, that our studies did not depict 2-dodecylcyclobutanone (2-DCB) as mutagenic. So Dr. Au is contradicting himself and his own knowledge. So again he is committing perjury.

Dr. Au also states in his declaration that he has reviewed relevant documents and studies. He ignores, however, several studies which have been published in the mean-time (2002-2005, the time between his affidavit of Dec. 10, 2002 and his recent declaration of Sept.29, 2005) which clearly show that 2-dodecylcyclobutanone is not mutagenic (Sommers 2003, Sommers and Schiestl 2004, Gadgil and Smith 2004). So this confirms my doubts that Dr. Au may be a respected environmental toxicologist, but that his knowledge of toxicology in the field of food irradiation is restricted. He simply ignores relevant papers about the mutagenicity of 2-ACBs, and he sticks to his old wrong opinion – even contradicted by himself in his peer-reviewed paper (Ashley et al., 2004) – that 2-ACBs are mutagenic.

Another case where Dr. Au shows his ignorance of the literature about food irradiation toxicology is in his above-mentioned paper Ashley et al., 2004. In this paper Dr. Au alleges the authors of the WHO Technical Report 890 (1999) “High-Dose Irradiation: Wholesomeness of Foods Irradiated Above 10 kGy” that they have ignored 5 peer-reviewed publications of Vijayalaxmi and co-workers in their Table on “In vivo mammalian mutagenicity studies”. However, Dr. Au has not recognized that this Technical Report – as its title clearly expresses – is dealing only with irradiation of foods above 10 kGy. Since the wheat experiments of Vijayalaxmi and co-workers were carried out with radiation doses below 10 kGy, these studies of course are not mentioned in the High-Dose Report. In a previous publication by the WHO “Safety and nutritional adequacy of irradiated food” (1994), the work of Vijayalaxmi is carefully reviewed and evaluated. So nothing remains of Dr. Au’s allegation.

Dr. Au also refers to one of our papers in his declaration stating that laboratory rats were fed **a very low** concentration of 2-ACBs in drinking water (Horvatovich et al., 2002). The uptake of 2-ACBs by the rats corresponded to about 1 mg / day. The daily uptake of 1 mg 2-ACBs per rat corresponds roughly to a daily consumption of about four irradiated (3kGy) cooked chickens (~1000 g, 12.5% edible fat) – and that every day up to 6 months. Therefore, I would not call this a very low concentration, but instead a very high concentration. We have used this high concentration of 2-ACBs in order to observe a possible toxicological effect – a usual procedure in toxicological experiments. It would have been desirable to do this experiment with a range of concentrations, thereby also estimating the concentration of 2-ACBs which causes no adverse effects. However, lack of capacity did not enable such a large experiment, and therefore only one concentration was tested. The estimation of the no adverse effect level in these kinds of experiments remains to be tested.

Since the amount of 2-ACBs formed is dependent on the radiation dose and the fat content in the food, it would be interesting to look at papayas. Papayas for quarantine treatment to eliminate fruit flies would be irradiated with a dose of about 250 Gy, so a much smaller dose than that used for poultry or beef. The fat content of papayas is also smaller than that of chicken, around 6% for whole papayas. So the amounts of papaya that the rats need to consume to achieve an intake of about 1 mg/day would amount to about 90 kg per rat per day. But there is an additional practical point which Dr. Au has totally ignored.

The proof of the papaya is the eating ! This is a slightly changed wording that everybody knows. This is also valid for irradiated papayas. It is correct as Dr. Au mentions in his declaration that 2-ACBs have been found in papayas and mangoes. They are even used to detect whether these tropical fruits have been exposed to a radiation treatment. However, the analysts trying to detect the 2-ACBs in papayas and mangoes – Ndiaye et al. 1999 and Stewart et al. 2000 are cited by Dr Au - these analysts use the seeds from the papaya and the mango kernels to isolate the fat, because the overwhelming quantity of lipids in these fruits is found in the seeds and not in the fruit flesh. Thus the dominant part of 2-ACBs is found in the seeds and not in the edible part of the fruit. The amount of actually consumed 2-ACBs will be extremely small, since the fat concentration in the edible flesh is only about 0.1%.

Since feeding experiments with quite high amounts of 2-ACBs such as the Raltech study (Thayer et al. 1987) in which highly irradiated (~58 kGy) chicken meat was fed to mice and dogs for long-term consumption yielded no adverse effects which could be attributed to irradiation, the safety factor for low-dose irradiated foods such as papayas and mangoes must be high – particularly when only a very small part of the radiation-induced 2-ACBs in these fruits will be consumed.

Food irradiation is toxicologically perhaps the most thoroughly investigated food processing technology in the world. A long list of mayor institutions endorses the irradiation of foods as safe, including the World Health Organization (WHO), the Centre for Disease Control (CDC) and the US Food & Drug Administration (FDA)

In conclusion, I hope that the people of Hawaii can now better judge for themselves about irradiated foods and the controversy surrounding the proposed irradiator at Honolulu airport. On my next visit to the United States, I am looking forward to eat high-quality irradiated papayas and mangoes from Hawaii and I hope that many consumers will have the free choice also to do so.

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Bibliography

Ashley BC, Birchfield PT, Chamberlain BV, Kotwal RS, McClellan SF, Moynihan S, Patni SB, Salmon SA, Au WW (2004) Health concerns regarding consumption of irradiated food. *Int. J. Hyg. Environ. Health* **207**, 1-12.

Burnouf D, Delincée H, Hartwig A, Marchioni E, Miesch M, Raul F, Werner D (2002) Etude toxicologique transfrontalière destinée à évaluer le risque encouru lors de la consommation d'aliments gras ionisés. Toxikologische Untersuchung zur Risikobewertung beim Verzehr von bestrahlten fetthaltigen Lebensmitteln. Eine französisch-deutsche Studie im Grenzraum Oberrhein. Rapport final / Schlussbericht INTERREG II, Projet / Projekt No. 3.171 in: Marchioni E, Delincée H, eds. *Berichte der Bundesforschungsanstalt für Ernährung, Karlsruhe*, BFE-R—02-02.

Delincée H (2003) Opinion on the Expert Affidavit on Safety Issues of Irradiated Food for School Children sworn by Dr. William Au, with date of Dec. 10, 2002. http://www.mnbeef.org/opinion_on_the_expert_affidavit_.htm.

Delincée H, Pool-Zobel BL (1998) Genotoxic properties of 2-dodecylcyclobutanone, a compound formed on irradiation of food containing fat. *Radiat. Phys. Chem.* **52**, 39-42.

Delincée H, Pool-Zobel BL (1999) Genotoxizität von 2-Dodecylcyclobutanon. In: Lebensmittelbestrahlung – 5. Deutsche Tagung, Karlsruhe, 11-12 Nov. 1998 (Knörr M, Ehlermann DAE, Delincée H, eds) *Berichte der Bundesforschungsanstalt für Ernährung, Karlsruhe*, BFE-R—99-01, pp.262-269.

Delincée H, Soika C, Horvatovich P, Reckemmer G, Marchioni E (2002) Genotoxicity of 2-alkylcyclobutanones, markers for an irradiation treatment in fat-containing food – Part I: Cytotoxic and genotoxic potential of 2-tetradecylcyclobutanone. *Radiat. Phys. Chem.* **63**, 431-435.

Gadgil P, Smith JS (2004) Mutagenicity and acute toxicity evaluation of 2-dodecylcyclobutanone. *J. Food Sci.* **69**, 713-716.

Horvatovich P, Raul F, Miesch M, Burnouf D, Delincée H, Hartwig A, Werner D, Marchioni E (2002) Detection of 2-alkylcyclobutanones, markers for irradiated foods, in adipose tissues of animals fed with these substances. *J. Food Prot.* **65**, 1610-1613.

Ndiaye B, Jamet G, Miesch M, Hasselmann C, Marchioni E (1999) 2-Alkylcyclobutanones as markers for irradiated foodstuffs. II. The CEN (European Committee for Standardization) method: field of application and limit of utilization. *Radiat. Phys. Chem.* **55**, 437-445.

Raul F, Gossé F, Delincée H, Hartwig A, Marchioni E, Miesch M, Werner D, Burnouf D (2002) Food-borne radiolytic compounds promote experimental colon carcinogenesis. *Nutrition and Cancer* **44**, 189-191.

- Sommers CH (2003) 2-Dodecylcyclobutanone does not induce mutations in the *Escherichia coli* tryptophan reverse mutation assay. *J. Agric. Food Chem.* **51**, 6367-6370.
- Sommers CH, Schiestl RH (2004) 2-Dodecylcyclobutanone does not induce mutations in the *Salmonella* mutagenicity test or intrachromosomal recombination in *Saccharomyces cerevisiae*. *J. Food Prot.* **67**, 1293-1298.
- Stewart EM, Moore S, Graham WD, McRoberts WC, Hamilton JTG (2000) 2-Alkylcyclobutanones as markers for detection of irradiated mango, papaya, Camembert cheese and salmon meat. *J. Sci. Food Agric.* **80**, 121-130.
- Thayer DW, Christopher JP, Campbell LA, Ronning DC, Thompson GM, Wierbicki E (1987) Toxicology studies of irradiation-sterilized chicken. *J. Food Prot.* **50**, 278-288.
- Vijayalaxmi (1975) Cytogenetic studies in rats fed irradiated wheat. *Int. J. Radiat. Biol.* **7**, 283-285.
- Vijayalaxmi (1976) Genetic effects of feeding irradiated wheat to mice. *Can. J. Genet. Cytol.* **18**, 231-238.
- Vijayalaxmi (1978) Cytogenetic studies in monkeys fed irradiated wheat. *Toxicology* **9**, 181-184.
- Vijayalaxmi, Sadasivan G (1975) Chromosomal aberrations in rats fed irradiated wheat. *Int. J. Radiat. Biol.* **27**, 135-142.
- Vijayalaxmi, Rao KV (1976) Dominant lethal mutations in rats fed on irradiated wheat. *Int. J. Radiat. Biol.* **29**, 93-98.
- WHO (1994) *Safety and nutritional adequacy of irradiated food*. WHO, Geneva.
- WHO (1999) *High-dose irradiation: wholesomeness of food irradiated with doses above 10 kGy*. Report of a Joint FAO/IAEA/WHO Study Group, WHO, Geneva, Technical Report Series No. 890.