AN ASSESSMENT OF THE RADIOLOGICAL SIGNIFICANCE OF CONSUMING WILD FOODS COLLECTED NEAR THE SELLAFIELD NUCLEAR FUEL REPROCESSING PLANT.

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1. Dose estimates and modelling of food pathway

Extensive monitoring of conventional agricultural produce in the vicinity of the BNFL Sellafield plant is undertaken, by both the operator and the Ministry of Agriculture, Fisheries and Food, to determine levels of radioactivity and doses(2) arising to the consumer. Monitoring is also undertaken(3), albeit less extensively, for market garden and domestic produce. By contrast, few data exist with respect to levels of radioactivity in 'wild foods' (e.g. hedgerow fruits, field mushrooms etc.) or associated consumption habits. It has been postulated that such foodstuffs could contribute an appreciable radiation exposure dose to groups of high level consumers, potentially including members of the existing identified critical group for local agricultural produce. This paper assess the actual radiological significance of wild foods collected near Sellafield.

2. The Habit Survey

A previous survey of the consumption of locally produced foods had provided useful information for the assessment of doses from food produced close to the Sellafield nuclear plant(1). In the current project, the habit survey had the main objective of identifying wild foods which could contribute to the ingestion dose. The survey was carried out during the spring and summer of 1994 by CN Research (Carlisle, UK). A total of 72 households were surveyed, and data collected for 181 individuals; comprising 3 infants (taken to be up to 2 years old), 21 children and 157 adults. Information was obtained on a total of 49 foods, including 9 species of fungi, 11 herbs, 16 fruits, 12 types of game, as well as nuts and honey; collected from areas near to Sellafield.

Table 1 Consumption Rate Data for some Key Foods

		Consumption rate (kg/year)			
Food	Number of Consumers	Mean	Max	Ratio max/mean	97.5th percentile
Venison	23	8.16	134.4	16.5	72.3
Blackberry	129	1.45	10.24	7.06	9.72
Honey	49	1.29	6.72	5.21	6.27
Elderberry	6	2.59	6.7	2.59	6.35
Pheasant	72	1.44	7.17	5.00	5.08
Fungi	64	0.57	4.98	8.74	2.06
Mallard	29	1.27	5.82	4.58	5.82
Nuts	30	0.49	2.56	5.22	2.56
Goose	10	1.08	2.69	2.49	2.59
Rabbit	7	0.86	1.34	1.59	1.34

In many cases, the maximum consumption rate of a food was much greater than the average value for all consumers of that food. In the most extreme case the maximum consumption rate for venison, by a game keeper, was 134 kg per year: 16.5 times the average value of 8 kg per year for all 23 consumers. This difference between the extreme rate and the average is, for wild foods, greater than for most conventional agricultural products, and requires special attention in the assessment of radiation doses from the consumption of wild foods.

In this survey, the consumption of wild fungi, although including a variety of species, was fairly low, being naturally limited by availability. The consumers of all wild foods were mainly adults, with generally insignificant consumption by infants and children.

3. Measurements of radioactivity in wild foods and consumption doses arising.

The information collected in the habit survey was used as a guide in the collection of samples of fruit, nuts, wild game (such as venison, rabbits, pheasant, duck and goose), as well as honey and fungi. Samples were measured for gamma emitters, actinides (plutonium and americium) and, on selected samples, ^{14}C and ^{129}I.

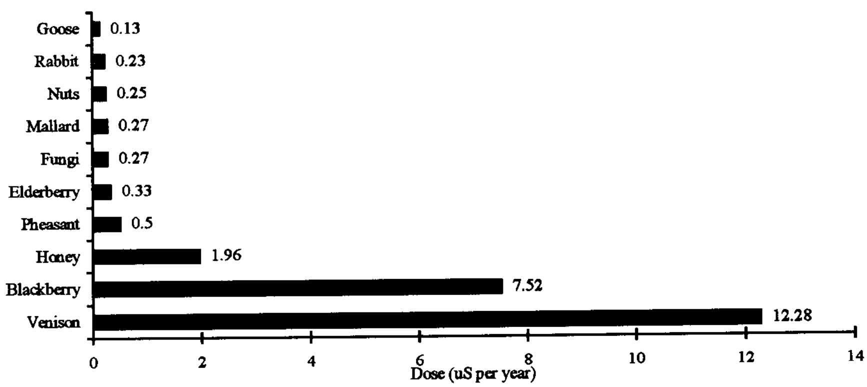
The dominant gamma emitter was ^{137}Cs; the highest concentrations being found in some samples of honey. Pollen analysis identified these honey samples as containing significant proportions of honey derived from heather. In West Cumbria heather grows on upland organic soils which received significant deposition from the Chernobyl accident in 1986. Table 2 compares two samples of honey from the area close to Sellafield.

Table 2 Comparison of caesium content and primary pollen source of upland and lowland honey from West Cumbria

	Upland honey	Lowland honey
^{137}Cs (Bq/kg)	254	21
Pollen Species:		
Calluna (heather)	71%	
Trifolium (clover)	9.2%	48%
rowan, hawthorn and cherry		20%

Figure 1 shows the contributions to the dose from wild foods consumed at the 97.5 percentile rates, assuming maximum measured radionuclide concentrations for each food, demonstrating the relative importance of blackberries and venison. In this assessment the upland honey samples were omitted, in order to avoid the inclusion of contributions from Chernobyl deposition through the heather-honey pathway.

Figure 1 Contributions to dose from different wild foods for the 97.5th percentile consumption rates



The dose from wild food can be compared to the critical group dose from locally produced agricultural products (e.g. milk, vegetables and meat); where the highest such dose was 24-54 μSv/year (Committed Effective Dose) to an infant in 1994, of which 7-36 μSv/year is from milk[2]. For an adult, more relevant for comparison to this project, the dose from local agricultural products is calculated to be 10-24 μSv/year committed effective dose (CED) of which 3-9 μSv/year is from milk.

The contribution to ingestion dose by individual radionuclides present in the wild foods is presented in Table 3. It can be seen that the dominant nuclide overall is ^{137}Cs, which may derive in this locality from Sellafield emissions, the Chernobyl accident and/or weapons test fallout.

Table 2: Committed effective dose based on 97.5th percentile consumption by an adult

	Effective dose (µSv/y)						Total	Collective dose*
Food	^{14}C	^{129}I	^{134}Cs	^{137}Cs	^{239}Pu	^{241}Am		µmanSv/y
Venison	0.00	0.00	0.45	11.82	0.00	0.00	12.28	282
Blackberry	0.57	0.49	0.22	5.99	0.11	0.24	7.62	983
Honey	0.08	0.00	0.12	1.67	0.10	0.003	1.96	96
Elderberry	0.00	0.31	0.00	0.02	0.01	0.00	0.33	2
Pheasant	0.03	0.17	0.00	0.30	0.00	0.00	0.50	35.8
Fungi	0.00	0.00	0.01	0.27	0.00	0.00	0.27	18
Mallard	0.00	0.00	0.00	0.27	0.00	0.00	0.27	8
Nuts	0.00	0.00	0.00	0.25	0.00	0.00	0.25	8
Goose	0.00	0.003	0.00	0.13	0.00	0.00	0.14	1
Rabbit	0.00	0.00	0.01	0.22	0.00	0.00	0.23	2
Consumption dose by isotope (µSv/y)	**0.68**	**0.97**	**0.81**	**20.9**	**0.21**	**0.24**	**23.8**	
%	**2.88**	**4.08**	**3.38**	**87.79**	**0.89**	**1.10**	**100**	

* *Collective dose is calculated only for the consumer group for each foodstuff: i.e. the 23 consumers of venison each receive just over 12 µSv per year, or collectively 282 µSv per year. This is a very narrow definition of collective dose, used only to illustrate the relative importance of each of the foodstuffs analysed.*

Considering both collective and individual dose, venison and blackberries dominate the consumption pathway, contributing 282 and 983 µmanSv per year respectively to the group of consuming individuals. Blacberries are of particular importance in calculating collective dose, because of their ubiquitous distribution and consumption.

4. Conclusions

The project has highlighted the importance of blackberries, which are easy to collect and are consumed by large numbers of people. Game (e.g. pheasant) is also important because of the concentrations of radiocaesium in game reared close to Sellafield and fed on locally grown grain. Venison is an example of unusual consumption patterns by a very small number of individuals. The radioactivity in honey was very variable, with some samples containing radiocaesium from Chernobyl through the soil-heather-honey pathway, whilst other samples contained very little anthropogenic derived radioactivity.

Overall, the extreme doses from wild foods are comparable with doses to the critical group for consumption of conventional agricultural produce from close to the Sellafield site, but the 97.5th percentile of the individual effective doses from wild foods are generally lower. All doses are well below applicable dose limits, even when the doses are assessed additively.

This study was funded by the Ministry of Agriculture, Fisheries and Food (Food Science Division). The authors are grateful to David Weir of English Heritage, London, for the pollen analysis of honey samples.

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