BLUEBERRIES AND RASPBERRIES SUBMISSION AGAINST IRRADIATION

Application: A1115 FSANZ

A look at the amazing qualities of Blueberries and Raspberries as major "Superfoods" that would not benefit at all from any irradiation treatment currently being assessed by FSANZ

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1. Executive Summary

Australian consumers enjoy at the moment, two major "Superfoods" of blueberries and raspberries which are renowned all over the world as a healer of the human body with numerous health benefits. The chances of a reduction in the antioxidants, anthocyanins and pterostilbene are very high if blueberries and raspberries are irradiated which in turn would turn consumers away from these foods which are within a growth industry in Australia.

There is no need to irradiate these wonderful berries supposedly as a quarantine measure for fruit fly and other pests as listed by FSANZ and the submission by New South Wales Department of Primary Industries (NSW DPI). There are alternatives to pest control and have been successfully used within many blueberry and raspberry farms. The other reason for irradiation is food pathogens entering the food supply through various extrinsic sources, such as faecal contaminated irrigation water supplies, farm workers, and food-processing plants. The farms themselves should be responsible for cleanliness of the food product. On these berry farms there should always be quality control as there currently is in Australia.

The research on losses of vitamins and minerals appear to be conflicting but it is not acceptable that the statement normal "storage and processing of non-irradiated fruit" would do this anyway. The potential of vitamin and "superfood" qualities to be lost within the irradiation technique would be high not low. Anthocyanin which is one of the antioxidants in blueberries has clearly shown [3]"*Anthocyanin is lost in any heat process and refrigeration of heat-treated anthocyanins results in degradation, with 60 days of storage at 31°C causing complete elimination of anthocyanins (despite other polyphenolics being preserved)."* [7] This would mean that the antioxidant of blueberries would be reduced or lost completely with the irradiation technique which shares some characteristics with microwaves, but with much higher energy and penetration. If these foods were frozen after irradiation, all antioxidants would be lost.

There is also a known result of Furan [8], a volatile genotoxic carcinogen to have been found in studies of irradiated blueberries and raspberry products. Any levels of Furan are unacceptable for human consumption.

With the market share just in the NSW blueberry crop increasing four-fold [8] in the past six years to be more than $100 million and, judging by expansion plans across the main growing region, the North Coast, that growth is likely to continue. Closely followed are raspberries, with national production rising from less than 500 tonnes a year in 2004 to in excess of 3000t in 2014.

Due to these reductions in antioxidants, consumers would react by no longer purchasing these foods. The cost of losing the "superfood" status of these berries would directly influence and reduce the Australian economy as well as turn the Australian consumer away from these natural healing berries.

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2. Purpose for irradiation

The quarantine measures for the control of fruit fly can be eliminated with the beneficial fungi and bacteria for controlling certain pests like Bacillus thuringensis; for controlling caterpillars, Pheromone dispensers; to disorientate the bad insects like Light Brown Apple Moth and the use of bait; to catch bad guys like Queensland fruit fly [1].

The other reason for irradiation is food pathogens entering the food supply through various extrinsic sources, such as faecal contaminated irrigation water supplies, farm workers, and food-processing plants. The farms themselves should be responsible for cleanliness of the food product. On these berry farms there should always be quality control of the food product. It is not common for farm workers to allow faecal contamination on a berry farm. There has not been any reported case of berries in Australia causing any health problems. Australian farmers should not suffer when they are doing the right thing and cleaning their farms and processing equipment therefore irradiation is not a requirement.

There are alternatives to control adult fruit flies for all fruits and vegetables. Therefore it is not necessary to irradiate fruits and vegetables.

3. Risk assessment

Taken from "Position Statement of The Food Commission (UK) July 2002 [13]

"Introduction
Food irradiation is being promoted by some international bodies and industry groups as the answer to the growing problem of food poisoning, and as a means to combat world hunger by reducing spoilage and extending food shelf life.

A proposal to relax the global standards governing food irradiation, including the removal of the current maximum irradiation dose limit, is now under discussion. The European Commission is also deliberating over whether to extend its list of foods permitted for irradiation in all EU member states.

The current list includes only herbs, spices and vegetable seasonings, but the possible extension would mean many other foods could be irradiated in all member states. Yet consumer concerns persist over the numerous potential negative impacts of irradiating food.

Health risks

- *Food irradiation can result in loss of nutrients, for example vitamin E levels can be reduced by 25% after irradiation and vitamin C by 5-10%. This is compounded by the longer storage times of irradiated foods, and by loss of nutrients during cooking, which can result in the food finally eaten by the consumer to contain little more than 'empty calories'. This is potentially damaging to the long and short-term health of consumers, particularly for sections of society already failing to obtain adequate nutrition.*

- *When food is exposed to high doses of ionising radiation, the chemical composition and nutritional content of food can change. Radiolytic by-products are often formed in irradiated food. Very few of these chemicals have been adequately studied for toxicity. One such chemical - 2-DCB - can cause DNA damage in rat colon cells at high doses.*
- *Food irradiation does not inactivate dangerous toxins which have already been produced by bacteria prior to irradiation. In some cases, such as C. botulinum, it is the toxin produced by the bacteria, rather than the bacteria itself, which poses the health hazard.*
- *Extension of the EU list of foods permitted for irradiation could mean that in future a significant part of the diet of consumers will consist of irradiated foods. The long-term impacts of this to health remain unknown. Far more research is required prior to exposing populations to such a diet.*
- *Irradiating products such as mechanically recovered chicken meat, offal and egg white, could mislead consumers into thinking these are safer. There is therefore a risk that consumers will fail to take necessary measures to prevent cross-contamination. The risk of recontamination of food after irradiation is very serious as a near sterile food is an ideal medium for very rapid growth of re-introduced bacteria. Irradiated food must therefore be handled with even greater care in homes and restaurants.*
- *Irradiation can cause mutations in bacteria and viruses leading to potentially resistant strains.*

Misleading consumers

- *Irradiating fruit and vegetables to extend their shelf life can mislead consumers by making 'old' food look 'fresh'. The greater the age of fruit and vegetables, the lower their nutritional value, not to mention the effects of ageing on their tastes and flavours.*
- *Consumers may be dangerously misled because irradiation also unavoidably kills off bacteria that produce warning smells indicating that the food is going 'off'.*
- *The irradiation of some products, such as dried fruit and flakes or germs of cereal, often considered as health foods (eg. muesli), could lead them to become misperceived by consumers as inherently contaminated food types.*

Misuse of the technology

- *Food irradiation can and has been used to mask poor hygiene practices in food production. With irradiation, contamination can be sterilised. This reduces the incentive to clean up sloppy food processing operations - the industry is provided with a 'quick fix' as an alternative to dealing with the sources of the problem. The consumer has a right to expect clean food, yet irradiation can lead to the increased production of food contaminated with dirt -'clean' dirt.*
- *Breaches of existing labelling legislation have occurred in European countries, with the sale of unlabelled irradiated foods. This was recently discovered to be occurring again by a UK government detection survey which found that nearly half the food supplements sampled were illegally irradiated and unlabelled (see press releases). Under these circumstances the consumers' right to choice is flouted. Relaxation of irradiation standards could worsen this situation.*

- *If they succeed, on-going industry efforts in the US to substitute the term 'irradiation' on irradiated food labels with terms such as 'cold pasteurisation' could serve to confuse and mislead consumers.*

The safety of workers

- *Workers risk accidental exposure to dangerous levels of radiation, particularly at irradiation plants using radioactive sources.*
- *The use of irradiation to sterilise meat at the end of the production line allows slaughter lines to be run at dangerously high speeds, since the greater contamination that occurs during high speed carving of carcasses can be 'cleaned up' at the end of the line. This approach increases the risk of accidents and fatalities by forcing meat packers to work faster than ever.*

Socio-economic costs

- *Food irradiation is not a low-cost method. Irradiation plants are expensive and could help large multinationals to eliminate smaller and more local producers. Requirements for improved security measures at all facilities holding radioactive materials are likely to increase the costs of irradiation plants, leading to an increase in the prices of irradiated foods.*
- *Irradiation supports greater globalisation of food production and supply, threatening local farmers and food processors.*

Environmental impacts

- *Accidents at radioactive irradiation plants have already led to radioactive spills and contamination of surrounding land and water resources. This could happen again.*
- *The construction of more irradiation plants could necessitate more transportation of radioactive materials, entailing risks of accidents and radioactive leaks over a wider area.*
- *Irradiation allows food to be transported over greater distances, leading to greater air pollution and greenhouse gas emissions which contribute to global warming.*

The Food Irradiation Campaign believes that:

- *The precautionary principle should be asserted until chemical by-products formed in irradiated foods have been adequately studied for toxicity in compliance with modern scientific protocols, and are proven safe for consumption.*
- *Food irradiation is no solution for cleaning up foods that are contaminated due to unhygienic production lines.*
- *Priority should focus on improving production, storage, and processing, rather than on killing off contamination at the last stage.*
- *Food irradiation benefits the industry rather than consumers, and large multinational companies rather than local and small-scale producers.*
- *Food irradiation works against local food supplies and its application for mass commodities is likely to undermine sustainability.*
- *Good food doesn't need irradiating."*

4. Hazard assessment

There is a known result of Furan [8], a volatile genotoxic carcinogen to have been found in studies of irradiated blueberries and raspberry products. The results were 1.3 (ppb) for blueberry spread and 6.3 (ppb) for raspberry spread and 3.1 for toppings of these fruits. Any levels of Furan are unacceptable. It is interesting to note that Safeway Hearty Beef and Country Vegetables Soup, measured at 125 (ppb) which surely should be unacceptable for human consumption.

The more irradiated food consumers are eating the more build-up of Furan within the human body is happening which in turn would create health issues and sickness with devastating results.

Foods that have been exposed to ionizing radiation have second-rate nutrition and "counterfeit freshness." Irradiated fats tend to become rancid. Even at low doses, some irradiated foods lose 20% of vitamins such as C, E, K, and B complex. Because irradiation breaks down the food's cell walls, accelerated vitamin losses occur during storage--up to 80%. Ironically, irradiation both creates harmful free radicals and destroys the antioxidant vitamins necessary to fight them! When electron beams are used, trace amounts of radioactivity may be created. In Europe, food irradiation has been used to camouflage spoiled seafood. Consumers should ask, "Why is the food suddenly so dirty that it has to be irradiated? [11]."

5. Nutritional assessment

Blueberries are not only popular, but constantly rank near the top in terms of their antioxidant capacities among all fruits, vegetables, spices and seasonings. Studies suggest that blueberries may reduce memory decline, may reduce heart attack risk, and may provide other anti-aging benefits. They are also an excellent source of vitamins C (which will be lost with irradiated food) and K, manganese and a good source of dietary fibre. Blueberries also have had a lot of studies (double blind) clearly showing *"DNA damage acutely decreased, decreases in blood pressure, improved cognition and memory, improved antioxidant status, insulin decreased in elderly persons. They may also have a role to play in promoting the growth of nervous tissue and reducing neurological inflammation" [7].*

A punnet of raw blueberries contains the following nutritional value for 100g [14] :

Energy	240 kJ (57 kcal)
Carbohydrates	14.49 g
Sugars	9.96 g
Dietary fiber	2.4 g
Fat	0.33 g
Protein	0.74 g
Vitamins	
Vitamin A equiv. beta-carotene lutein zeaxanthin (0%) 32 µg 80 µg	

Vitamin A	54 IU
Thiamine (B1)	(3%) 0.037 mg
Riboflavin (B2)	(3%) 0.041 mg
Niacin (B3)	(3%) 0.418 mg
Pantothenic acid (B5)	(2%) 0.124 mg
Vitamin B6	(4%) 0.052 mg
Folate (B9)	(2%) 6 µg
Vitamin C	(12%) 9.7 mg
Vitamin E	(4%) 0.57 mg
Vitamin K	(18%) 19.3 µg
Minerals	
Calcium	(1%) 6 mg
Iron	(2%) 0.28 mg
Magnesium	(2%) 6 mg
Manganese	(16%) 0.336 mg
Phosphorus	(2%) 12 mg
Potassium	(2%) 77 mg
Sodium	(0%) 1 mg
Zinc	(2%) 0.165 mg
Other constituents	
	Water 84 g

Raspberries also rank high on the nutritional value [13]:-

Nutritional value per 100 g (3.5 oz)	
Energy	220 kJ (53 kcal)
Carbohydrates	11.94 g
Sugars	4.42 g
Dietary fiber	6.5 g
Fat	0.65 g
Protein	1.2 g
Vitamins	
Thiamine (B1)	(3%) 0.032 mg
Riboflavin (B2)	(3%) 0.038 mg
Niacin (B3)	(4%) 0.598 mg
Pantothenic acid (B5)	(7%) 0.329 mg
Vitamin B6	(4%) 0.055 mg
Folate (B9)	(5%) 21 µg
Choline	(3%) 12.3 mg
Vitamin C	(32%) 26.2 mg
Vitamin E	(6%) 0.87 mg
Vitamin K	(7%) 7.8 µg
Minerals	
Calcium	(3%) 25 mg
Iron	(5%) 0.69 mg
Magnesium	(6%) 22 mg
Manganese	(32%) 0.67 mg

Phosphorus	(4%) 29 mg
Potassium	(3%) 151 mg
Zinc	(4%) 0.42 mg

As you can see these amazing berries deliver high nutritional value and have to be protected in keeping these minerals and vitamins from being lost in the irradiation process. There is no excuse for irradiation and consumers usually buy these products fresh so no nutritional value is lost when eating non-irradiated food.

6. Market share

As the popularity of blueberries and raspberries grows, our growers respond in kind. [1] "*Each year, Australian farmers grow 6,000 tonnes of blueberries with a farmgate value of $A120 million. Of these:*

- ★ *75% is sold fresh within Australia*
- ★ *10% is exported to Asia and Europe*
- ★ *15% is processed, mainly as frozen product*

With the market share just in the NSW blueberry crop has increased four-fold [2] [9] outstripping supply in the past six years to be more than $100 million and, judging by expansion plans across the main growing region, the North Coast, that growth is likely to continue.

Raspberries have also been more popular, with national production rising in NSW from less than 500 tonnes a year in 2004 to in excess of 3000t in 2014."

The loss and cost of "Superfood"status would directly influence and reduce the Australian economy.

7. Dietary Intake assessment within diets

Families around Australia enjoy fresh blueberries every day during the growing season between December to March in the southern regions, June to February in the northern regions and frozen berries all year round. It is common for meals for children to include blueberries and raspberries as snack to help them with their antioxidant levels and also used as a tasty snack for children when they come home from school. Women especially know the value of these raw superfoods to ensure the good health of their children and themselves [5].

"*Of all the so-called superfoods — the nutrient-rich foods high in antioxidants that are thought to fight the ills of aging — few receive more accolades than the berry family. From humble blueberries to their exotic cousins from distant climes, berries have muscled out*

other super fruits to take a firm stand front and centre. Sure, orange fruits and dark leafy greens get their fair shake, but the berries seem to steal the show.

And the attention bestowed on berries is not unfounded. In study after study, the benefits of berries are lauded. Most recently, researchers revealed that women who ate more than three servings of blueberries or strawberries a week had a 34 percent lower heart attack risk than those who ate less. Researchers say the reason is that the berries, like other red and blue fruits and vegetables, have high concentrations of anthocyanin, an antioxidant that may help lower blood pressure and improve blood vessel function. Another study found that women who eat plenty of blueberries and strawberries experience slower mental decline with age than women who consume fewer of the fruits."

8. Risks to public health and safety

Based on the hazard, nutrition and dietary intake assessment components, the risk to public health and safety has been characterised.

There has been a U.S. Congressional hearing into food irradiation [12] which had expert testimonies from scientists around the world who found major problems with irradiating food:-

- *"Eating irradiated wheat-based diets is associated with undesirable consequences and reiterates its recommendation that should wheat be irradiated for human consumptions it must be stored for at least 12 weeks before being released for use. There were unexplained stillbirths in the litters of rats given wheat irradiated with twenty thousand rads; recalculation of that stillbirth rate shows a significant increase. This study is hardly an endorsement for the safety of irradiating food. The other study, intensively reviewed, has similar problems. I wish to reiterate that the Institute has NOT withdrawn anything which it said earlier on this subject and stands fully behind all that it has published. Indeed, its stand has received support from the publications of both Renner and Anderson and coworkers. The Institute also does not agree with the Kesavan-Sukhatme report. It stands behind its statement that eating irradiated wheat-based diets is associated with undesirable consequences and reiterates its recommendation that should wheat be irradiated for human consumptions it must be stored for at least 12 weeks before being released for use. (S. G. Srikantia, B.Sc.,.B.B.S., D.Sc. Professor of Foods and Nutrition, University of Mysore, India)*

- *I do not believe that irradiated foods have been shown to be safe for general consumption. Equally important, the effects of irradiation on the nutrient contents of food are not established. I believe the prudent action to take is to prohibit the irradiation of food until the basic issues are sorted out. To do less would be irresponsible. (Donald R Louria, Ph.D.)*

- *I am opposed to consuming irradiated food because of the abundant and convincing evidence in the refereed scientific literature that the condensation products of the*

free radicals formed during irradiation produce statistically significant increases in carcinogenesis, mutagenesis and cardiovascular disease in animals and man. I will not address the reported destruction of vitamins and other nutrients by irradiation because suitable supplementation of the diet can prevent the development of such potential deficiencies. However, I cannot protect myself from the carcinogenic and other harmful insults to the body placed into the food supplies and I can see no tangible benefit to be traded for the possible increased incidence of malignant disease one to three decades in the future. (George L Tritsch, Ph D)"

Studies [4] [9] [10] have found that the radiolytic derivatives of triglycerides found exclusively in irradiated food have created lesions (in the colon) and tumours within the test subjects:-

"*Information on the toxicological potential of 2-alkylcyclobutanones (2-ACBs), radiolytic derivatives of triglycerides found exclusively in irradiated food, is scarce. Wistar rats received daily a solution of highly pure 2-tetradecylcyclobutanone (2-tDCB) or 2-(tetradec-5-enyl)-cyclobutanone (2-tDeCB) at a concentration of 0.005% in 1% ethanol as drinking fluid, while control animals received 1% ethanol. All animals received a single intraperitoneal injection of the chemical carcinogen azoxymethane (AOM) at Weeks 3 and 4. At 3 mo after AOM injection, no significant changes were observed in the total number of preneoplastic lesions in the colon of AOM controls and 2-ACB-treated animals. After 6 mo, the total number of tumors in the colon was threefold higher in the 2-ACB-treated animals than in the AOM controls. The colon of four of six AOM control rats exhibited only one small tumor (&6 mm3). Multiple tumors were observed in four and three of six animals treated with 2-tDCB or 2-tDeCB, respectively. Medium (6 < S < 25 mm3) and larger (>25 mm3) tumors were detected only in 2-ACB-treated animals. "*

This is the first demonstration that a compound found exclusively in irradiated dietary fats may promote colon carcinogenesis in animals treated with a chemical carcinogen.

Only two human studies have been reported. In one study, ten children (2 to 5 years old) suffering from severe protein-calorie malnutrition were fed freshly irradiated wheat (N = 5) or stored irradiated wheat (N = 5) for six weeks [4]. These ten children were compared to a matched control group of five children who were fed unirradiated food during the same time period. The first group of five children developed significantly more polyploid cells (having multiple sets of chromosomes) and other cellular abnormalities in their lymphocytes than the five who were fed the stored irradiated food. In addition, the abnormality persisted for up to two months after the feeding period ended. None of the children fed the unirradiated diet developed any abnormal cells."

In the study [4], healthy adults were fed irradiated food for three months. They did not display any increase of chromosomal aberrations when compared to a control group. Upon reanalysis of the data [9], an increase in chromosomal aberrations was demonstrated. Although these results were from small scale investigations, the information is based on human responses and does raise some safety concerns about the health risk of irradiated food.

Potentially Harmful Radiolytic Products

In the modem era, a new concern has arisen in regard to some of the radiolytic products formed uniquely in irradiated food. Of particular interest is Z-ACB, a radiolytic derivative of triglycerides. In one report [4], "*Laboratory rats were fed a low concentration of 2-ACBs in drinking water, and the absorption and excretion of the chemicals were monitored. The study showed that a substantial portion of the chemical crossed the intestinal barrier, entered the blood stream, and accumulated in adipose tissue. Therefore, consumption of irradiated food can possibly result-major significant alterations in the adipose tissues of consumers. The long-term health consequences of this observation are unclear at this time.*

The adverse health effects from consumption of products that contains 2-ACBs, unique radiolytic products, have not been fully and adequately characterized (Horvatovich et al., 2002). Two 2-ACBs were briefly tested for tumor promoting activities in an experimental colon tumor model and one was active (Ram et al., 2002). In irradiated food for human consumption, the concentration of 2-ACBs is estimated to be low, e.g. 0.5 ug/gram of lipid at 5 kGy (WHO, 1999). However, in a different but well-established tumor promotion animal model, the dose that was needed to promote tumors was lower than 0.5 ug per mouse, delivered two times per week for 25 weeks (Saleem et al., 2001). Another way to consider the dosage situation is that the concentration of tumor promoters is usually hundreds of times less than the cancer inducing chemicals. Therefore, 2-ACB in irradiated food can potentially be hazardous to humans. "

"Food irradiation exposes food [6] to the equivalent of 30 million chest X-rays.
Irradiation creates new chemicals in foods called radiolytic products. Some of these products are known cancer-causing substances (like benzene in irradiated beef). Others are unique to the irradiation process and no one knows what effects these have on human health.

Irradiation destroys essential vitamins and nutrients that are naturally present in food. No studies have been done to show that a long-term diet of irradiated foods is safe. Safer, well-tested alternatives to irradiation exist".

9. Conclusion

It is imperative that Australia does not lose the "superfood" status of these berries by irradiating these foods with the potential to lose antioxidants, vitamins, minerals etc. and losing not only consumers but the market share to sell these wonderful berries to overseas countries and to all Australians.

There are other methods to manage the pests and diseases of these plants and have been used successfully in the blueberry and raspberry industries of Australia for decades. Irradiation is not necessary.

Why is the food suddenly so dirty that it has to be irradiated? The potential for loss is great and this should be considered in all aspects as there is no gain from irradiating these wonderful berries.

As the vision for FSANZ is to have a safe food supply protecting and supporting the health of people in Australia and New Zealand, you would think that it would be imperative that FSANZ would support these wonderful superfoods in their current status that have done no harm and yet continue to give us a wonderful taste, nutrition level and certainly proven status of a "superfood".

Economic risks to Australian farmers and health risks to consumers are not worth the process of irradiating these foods. Let the massive growth industry of raspberries and blueberries continue in our country and let them continue to improve our health and nutrition.

10. References

1. Australian Blueberries. (2015, October 21). *Australian Blueberries*. Retrieved from http://www.australianblueberries.com.au: http://www.australianblueberries.com.au/blog/2015-10-21/an-integrated-approach-to-pest-management
2. *Australian Blueberries*. (2016). Retrieved from Berry Interesting facts: http://www.australianblueberries.com.au/is-good/berry-facts
3. Bhaskaram, C., & Sadasivan, G. (1975). Effects of feeding irradiated wheat to malnourished children. *American Journal of Clinical Nutrition 28:*, 130-135.
4. Bradford, C., Ashley, C., Patrick , T., Birchfield, T., & Blake, V. (2004). Health Concerns Regarding Consumption of Irradiated Food. *International Journal of Hygiene and Environmental Health press*.
5. Breyer, M. (2013, April 16th). *Superfoods: 11 berries to improve your health*. Retrieved from Mother Nature Network: http://www.mnn.com/food/healthy-eating/stories/superfoods-11-berries-to-improve-your-health
6. Dr. Gayle Eversole, P. N. (1998, April 15). *The Dangers of food irradiation*. Retrieved from rense.com: http://www.rense.com/general81/foodr.htm
7. Examine.com. (2013). *Blueberries*. Retrieved from Scientific research on blueberries: https://examine.com/supplements/blueberry/
8. FDA American Government website. (2004, May 7). *Exploratory Data on Furan in Food: Individual Food Products*. Retrieved from http://www.fda.gov: http://www.fda.gov/Food/FoodborneIllnessContaminants/ChemicalContaminants/ucm078439.htm
9. Goodwin, S. (2015, January 15). *The Land*. Retrieved from www.theland.com.au: http://www.theland.com.au/story/3370921/blueberry-demand-outstrips-supply/
10. Louria, D. (2001). Food Irradiation: Unresolved Issues. *Oxford Journals: Clinical infectious diseases: Vol 33, Issue 3*, 378-380.
11. Raul, F., Gosse, F., Delincee, H., Hartwig, A., Marchioni, E., Miesch, M., . . . Burnouf, D. (2002). Food-borne radiolytic compounds (2-alkylcyclobutanones)may promote experimental colon carcinogenesis. *PubMed US Library of Medicine 44:*, 189-191.
12. U.S. Congressional Hearing. (1987, June 19). *Potential Health Hazards of Food Irradiation*. Retrieved from http://www.ccnr.org/: http://www.ccnr.org/food_irradiation.html
13. United Kingdom Food Commission. (2002, July). *http://www.foodcomm.org.uk/*. Retrieved from The Food Commission: http://www.foodcomm.org.uk/campaigns/irradiation_concerns/
14. USDA. (2016, May). *United States Department of Agriculture* . Retrieved from Food composition database: https://ndb.nal.usda.gov/ndb/search/list