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Wholesomeness of irradiated food

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HIGHLIGHTS

- Processing of food by ionizing radiation is safe and wholesome.
- Conclusion adopted by WHO and by many international and national bodies.
- Review of pertinent publications confirms this observation again.
- Several consumer groups and even a few governments fundamentally oppose food irradiation for various reasons.

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ABSTRACT

Just with the emergence of the idea to treat food by ionizing radiation, the concerns were voiced whether it would be safe to consume such food. Now, we look back on more than hundred years of research into the 'wholesomeness', a terminology developed during those efforts. This review will cover the many questions which had been raised, explaining the most relevant ones in some detail; it will also give place to the concerns and elucidate their scientific relevance and background. There has never been any other method of food processing studied in such depth and in such detail as food irradiation.

The conclusion based on science is:

Consumption of any food treated at any high dose is safe, as long as the food remains palatable. This conclusion has been adopted by WHO, also by international and national bodies. Finally, this finding has also been adopted by Codex Alimentarius in 2003, the international standard for food. However, this conclusion has not been adopted and included at its full extent in most national regulations.

As the literature about wholesomeness of irradiated food is abundant, this review will use only a few, most relevant references, which will guide the reader to further reading.

1. Introduction

When ionizing radiation was first discovered, the nature of this effect remained quite strange, un-understandable, being particles as well as photons. Quite remarkable, as early as this new kind of radiation had been discovered, first proposals have been made for its exploitation.[2] It turned out it was not a property of the rays, particles or photons, but the effect of energy transferred by their interactions. The new effect was '*ionization*', i.e. creating charges on molecules by expelling electrons and by breaking molecular bonds; later on it was detected that also 'free radicals' are formed, i.e. shifting the position of electrons on molecules without creating any charge. Both kinds of effects were likewise effective in creating significant chemical changes, finally resulting also in the useful effects to be exploited. However, the nature of those effects was understood only after decades of intense research. Some research revealed quite useful applications becoming available; however, several concerns about possible negative effects could not be answered initially. This was true for treating food by ionizing radiation as well as in industrial as in therapeutic applications. The concern with food was induced radioactivity, the creation of new toxic substances and compounds, and the formation of genetic changes and more.

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[2] Minck, F. (1896) Zur Frage über die Einwirkung der Röntgen'schen Strahlen auf Bacterien und ihre eventuelle therapeutische Verwendbarkeit. [About the effect of X-rays (Röntgen-rays) on bacteria and their possible therapeutic exploitation]. Münchener Medicinische Wochenschrift 43 (5), 101–102.

It should be noted this first ever publication contained a range of experimental errors and was superseded by a corrected version later on.

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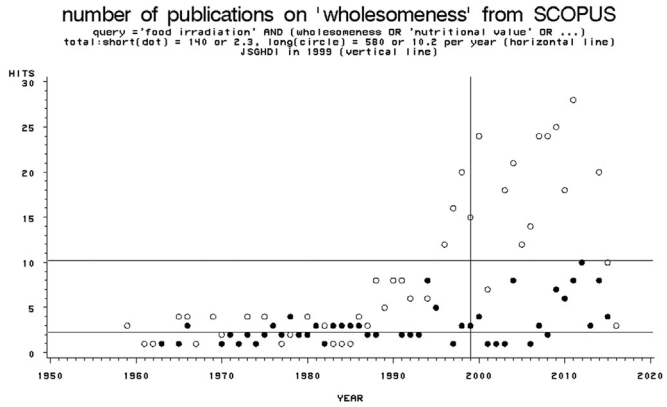

Fig. 1. The course by time of the number of publications on the wholesomeness of food.

Note: The terminology of 'wholesomeness' must be recognized and understood at its full extent (from the Shorter Oxford English Dictionary): 'whole'="in good condition, sound"; 'wholesome'="tending to do good; beneficial, salutary". This meaning implies not only that any deleterious or noxious effect is absent.

The publications in the field of food irradiation are abundant, and the number on wholesomeness is still increasing (cf. Fig. 1); consequently, this report is more a survey, and not at all a typical academic review. For this reason, a quite different approach is chosen here, including the structure of the references. Full details for all the many effects and concerns are found elsewhere, being discussed only in the few central references given here. The reader should be guided by the two groups of references: Group A: the standard references to conclusions by international experts, as well as a very few fundamental publications; Group B: a list of a few out-standing references for positive and negative findings and aspects; examples for further reading. Footnotes are used to link specific references directly to the discussed topic.

It is quite remarkable how the international scientific community joined their efforts (despite being hampered by the Iron Curtain): national research laboratories co-operated; governments created a forum IFIP (International Food Irradiation Project at Karlsruhe, Germany) to co-ordinate the research, to discuss and evaluate results obtained, to publish joint research, develop new tasks from the results obtained. These and other results were the fundament on which JECFI (FAO/IAEA/WHO Joint Expert Committee on Food Irradiation) was created to parallel the JECFA (Joint Expert Committee on Food Additives) and to determine whether irradiated food is 'wholesome' to consume.

2. The judgement by the international scientific community

Rather late, an international co-ordination of the manifold and spread activities into research about the wholesomeness of irradiated food commenced; before this, even national co-ordination was rare. A Joint FAO/IAEA/WHO Expert Committee on Food Irradiation (JECFI) was already convened in 1963, first time. The International Project in the Field of Food Irradiation (IFIP) was founded by a number of countries in 1970, with an administrative seat at the (then) Federal Research Centre of Food Preservation, Karlsruhe Germany. A wide range of research projects was started and co-ordinated, more and more countries joined this project. The several reports by JECFI and by IFIP make evident the initial uncertainty about a possible outcome (positive or negative), the intention to avoid a diffuse approach, but the aim to achieve the goal stepwise. In 1983 the IFIP ended its activities (finally closed in 1984) for the reason that its purpose had been achieved with the final conclusion by JECFI in 1983 that any food irradiated upto10 kGy (grand average) is save to consume. This included the conclusion that in a long term consumption of irradiated food receiving at the average 10 kGy, and receiving at up to 95% a dose up to 15 kGy, as long as the grand average of 10 kGy is observed, would be save to consume; with the consequence that the 5% remaining might receive even any dose above the 15 kGy. This makes evident that the experts did not see any particular health significance even at higher doses. This implies also that no health problems arise when some minor part of the food is irradiated even at extremely high doses. Only in 1999 a Joint FAO/IAEA/WHO Study Group on High-Dose Irradiation (JSGHDI) was convened, which concluded that even any upper dose limit was dispensable. Finally, Codex Alimentarius also adopted this position in 2003. It might also be noted that the amount of publications on wholesomeness continued to increase even drastically after the findings of the JSGHDI in 1999 (see Fig. 1).

Many fundamentals and details of such research can be found in a textbook by Diehl (1995) and in two publications by WHO (1994 and, 1991). The several specific studies and publications after this textbook, and after JECFI and JSGHDI just confirm the earlier general findings and add same details, but do not put in question the fundamental conclusions.

It should be noted that with the end of IFIP in 1983 the International Consultative Group on Food Irradiation (ICGFI) had been founded in 1984; it served the information exchange between its member states, in particular about further work and results about wholesomeness, but also about the world-wide regulations in radiation processing of food and about respective international trade; ICGFI was ended in 2004. The many reports from ICGFI are accessible through the Food and Environment Protection Section (FEPS) of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna.

3. Radiation processing by irradiation in general

It must be kept in mind what the purposes of processing food by ionizing radiation are and in which relation the objectives achieved must be seen with regard to possible and hypothetical risks:

Low dose (up to 1 kGy)	
Inhibition of sprouting	potato, onion, garlic, ginger root, chestnut
Insect disinfestations	cereals, pulses, fresh and dried fruits,
Parasite disinfection	fresh pork and fish
Delay of ripening	tropical fruits
Medium dose (1–10 kGy)	
Extension of shelf-life	fish and seafood, strawberries, asparagus
Inactivation of spoilage and pathogenic bacteria	raw and frozen seafood, meat and poultry, chicken feet, raw milk cheese, life oysters
Improving technological properties	increased juice yield (grapes), reduced cooking time (dehydrated vegetables)
High dose (above 10 kGy)	
Industrial sterilization (combination with mild heat)	meat, poultry, seafood, sausages, space food, prepared meals, hospital diets
Decontamination of additives/ingredients	spices, enzyme preparations, natural gum, gel

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