

# FREE RADICALS IN FOOD AND BIOLOGICAL SYSTEMS A REVIEW

*Elkenah C. Ndie*

## **Introduction**

Free radicals are those components that due to their chemical nature are more reactive than other components within their environments. Free radicals are found both in the food and also in the body at cellular levels. Nutritionists are interested in free radicals first because of their actions on food deteriorations and secondly because of their toxic effect on the body. Recently a lot of nutritional advices in food journals and magazines are focused on use of antioxidants to counter the action of free radicals both in food and in the body. The aim of this review is to summarize some key papers with regards to free radicals in food and biological systems as well as their control.

**Chemistry of free radicals:** According to Found (2005) free radicals can be generated by any of the following mechanism.

1, Hemolytic cleavage of a covalent bond, in which a normal molecule fragments into two, each fragment retains one of the paired electrons. Hemolytic cleavage occurs less commonly in biological systems as it requires high – energy input. It is common in food irradiation and in deep fat frying.

2, Loss of a single- elections from a normal molecule.

3, Addition of an election from a normal molecule.

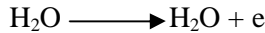
The fundamental fact about radical is that the unpaired elections in their outer shall do not affect the charge on the resultant and molecules free radicals can be negatively charged, positively charged or electrically neutral. This is because charge concerned with the number of negatively charged electrons in relation to the positively charged protons whereas free radicals are related only to the spatial arrangement of the outer electron.

The unpaired elections may have been gained on top of a neutral molecule making it negative; alternatively, it may have resulted from the loss of an electron from the same molecule resulting in a positive charge. Likewise, if the original molecule was not neutral to begin with, the addition or removal of an unpaired electron would result in a neutral charge. Free radicals are atoms or molecules that have at least one unpaired electron, which makes them very reactive with other molecules (Bates 2005).

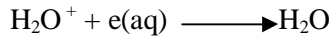


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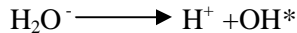
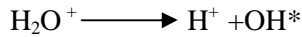
ii. **Food irradiation process:** Urbain (1996) stated that generation of free radicals by gamma irradiation in biological materials starts with knocking out a quantum of electron from water in the environment as follows.



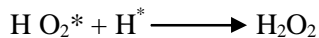
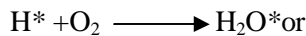
The ejected electron may have enough energy to repeat the above reaction or may be captured to form a negative water ion.



The positive and negative water ions dissociate as follows



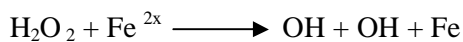
The  $\text{H}^*$  (free radical) may react with oxygen to form an oxide free radical such as  $\text{H}_2\text{O}^*$  via



These free radicals are found in food preserved by gamma irradiation (Wang and Brynolfussian 1993, Okoli, 1998)

iii, **Enzymatic oxidation:** Fun (2005) stated that a variety of enzymes (most of which are used in food processing) are capable of generation significant amount of free radicals. The enzymes include xanthenes oxidase, prostaglandins, synthesesase, lipoxygenase and amino acid oxidase.

iv, **Transition metal ions:** Iron and copper play a major role in the generation of free radicals and the facilitation of lipid peroxidation participate in the Haber- Weiss reaction that generates OH from  $\text{O}_2$  and  $\text{H}_2\text{O}_2$



The Haber- Weiss reaction accelerates the nonenzymatic oxidation of molecules such as epinephrine and glutathione that generates  $O_2$  and  $H_2O_2$  and subsequently. OH. (Hirs 1967).

- v, **Tissue injuries** : Tissue injury confers a number of effects that contribute to the production of free radicals . Normally xanthine oxidase is known to catalyze the reaction of hypoxanthine to xanthine and subsequently xanthine to uric acid. This reaction requires an electron acceptor as a co-factor. During tissue injuring two factors occur, first the production of xanthine and xanthine oxidase are greatly enhanced. Secondly, there is a loss of both antioxidants superoxide dismutase and glutathione peroxides. The molecular oxygen supplied on reperfusion serves as an electron acceptor and cofactor for xanthine oxidase catalyzed reaction and generate free radicals in skeletal muscles and myocardium (Hu and Cassaine 2000, Found 2005).

**Measurement of free radicals and antioxidants:** There is an increase interest in need for techniques to measure free radicals and antioxidants both in vivo and invitro. Many technical problems are encountered in measurement of free radicals and antioxidants. The problems are four:

- i: **The ultra** – short half- life of these radicals (usually measured in microsecond.)
  - ii: Free radicals produced in vivo and in vitro react very close to their source of formation. So the methods to quantify free radicals are usually indirect.
  - iii: Many of the products formed from the radicals are themselves reactive although to a lesser degree.
  - iv: The only samples that are readily available for measure of free radicals in the body of man and animals are urine, blood and expired breath and it is almost impossible for free radicals observed or produced in intestine measured because of very short half life, (Brunswick 2006). To overcome the above problems the following methods have been developed though with limitation (Brunswick 2006).
- i. **Assay methods:** Some laboratories have developed assay method for specific free radicals. Brunswick’s laboratories has develop assay method which they called ORAC free radical tests. Brunswick’s prepared assay can be used to quantify peroxy, hydroxy, and super oxide. The major problems of this test is that the sample must be urine, blood, expired air or sweat which may not give true picture in the body.
  - ii. The only analytic technique that directly measures free radical is Electron Resonance Spectrometry. It involves the addition of a

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compound known as a spin trap that rapidly with free radicals to form products that are very much more stable and have longer half- life than the original species. The use of this method is limited in vivo for the fact that it requires concentration of free radicals in the macromolecular range and this may be impossible.

- iii. Measurement of non-radical products of free radicals. Here the compound produced when the free radicals react with antioxidants are measured these substances are not produced normally hence their presence is evidence of free radical production. This method again can only produce semi-quantitative data.
- iv. Measurement of DNA damage: Free radical are known to produce irreversible modification in DNA. These DNA products and the repair enzymes are excreted in urine either as free base or as the nucleoside derivatives. These products can form an index of free radical attacks against DNA. This method is limited due to the obscurity of the tissue of origin of the products.

### **Mode of Actions of Antioxidants in Biological System**

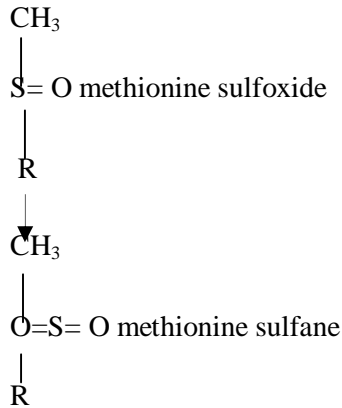
From available literature the protective system against oxidative stress caused by free radicals in the biological systems include enzymes such as superoxidase and dimutase as well as antioxidants and radical scavenger such as tocopherol (vit.E), B-carotenes, methionine and ascorbic acid (Steinbery 1993) Vitamin E and C and B- carotene get rid of free radical in the body system making them less harmful. According to Steinbery (1993), this reaction turns vitamin E itself into a potentially damaging radical that in turn reacts with B-carotene which inactivates the newly formed vitamin E radical. Finally vitamin C in turn neutralizes the resulting carotene and since the complex with vitamin C is soluble it is ultimately excreted through the urine. In other words for effective antioxidant action in the biological system vitamin E, C, and B- carotene are needed in the diet.

Levine and Stodtman (1997) in their study of methionine residues as endogenous antioxidants in protein stated that amino acid methionine functions as a protein ultimate defense against free radical damages. Methionine is an essential amino acid chemical structure.



It is sulfur containing amino acid and since sulfur has six electrons on its valency, Lewis formula is C:S:C.

According to the two free electron makes it a good antioxidant and may engage either one or both of the free electron pairs of sulfur resulting in the formation of methionine sulfoxide.



Oxidation of methionine to the reversible methionine sulfoxide by the free radicals occur preferentially when other amino acids are present and none of the free radicals identified in food oxidize methionine beyond the sulfoxide state. Moreover these studies also show that some enzymes can restore methionine sulfoxide to its original state, thereby setting up a cycle that renews its protective antioxidant activities. Hires (1997) stated that formation of methionine sulfane which is more stable than sulfoxide required harsh treatment. Such treatments are not likely to be obtained in the biological system.

Amen's et al., (1983) in their own study stated that catalyze oxidation of uric acid by organic free radicals like myeloperoxidase, cytochrome oxidase and hydroperoxidase occur in the body. Based on the above findings, they went on to postulate that the role of urates is to help suppress lipid oxidation in erythrocytes and as well as a scavenger of singlet oxygen, hydrogen, radicals and oxo-heme oxidants. The increase in urate level in exercise, lead exposure and obesity suggest a causal relationship with free radical generation.

## **Conclusion**

From the on going discussion, it is clear that free radicals in food get into the body but the effect have not been established and till this is done nutritionist should continue to view the free radicals in processed food in terms of their effect on food spoilage. It have been clearly demonstrated that food nutrients like vitamin E and C, B- carotene and methionine have controlling effect on the damage to the body by free radicals generated during the body metabolism. It is then the duty of the food scientist and nutritionist to develop methods of supplementing these food nutrients in processed food. This is to

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enable health educators like public health nurses to educate the general public on the right food that are rich in antioxidants rather than giving speculative scientific informations.

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