BIOCHEMICAL STUDIES ON LIPIDS AS AFFECTED BY GAMMA IRRADIATION

BY

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B.Sc. Agric. (Biochem.) Ain Shams Univ., 1982

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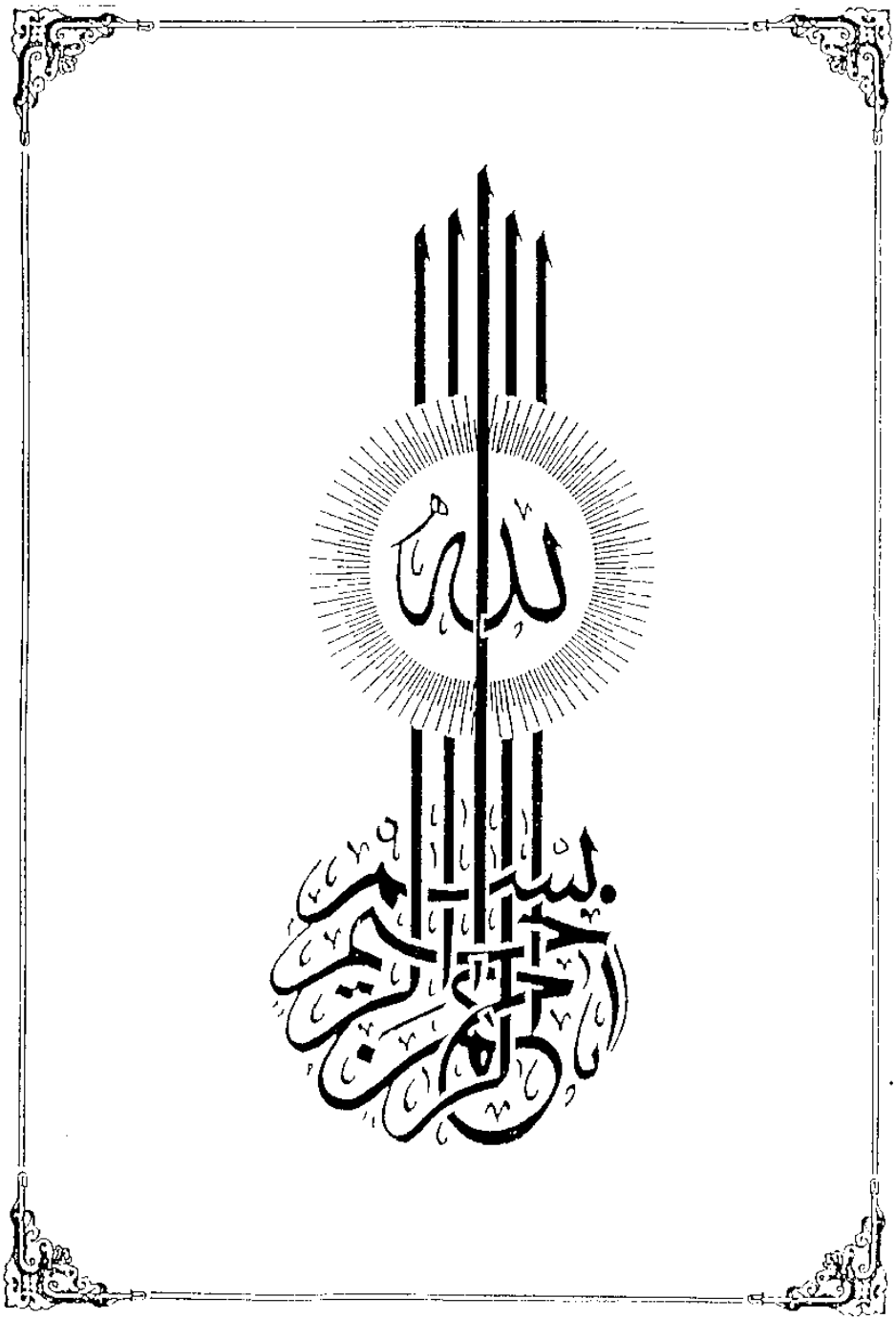

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ABSTRACT

The aim of the present work was to study the effect of gamma radiation on some edible oils under different conditions. Corn and olive oils were treated by gamma radiation at dose levels of one or three Mrad either in presence or in absence of air oxygen.

The study can be classified into two main parts; chemical and biological one. The chemical part was carried out to investigate some chemical characteristics (acid value, peroxide value, saponification value, iodine value,

TBA value and fatty acids composition) of the irradiated and stored oils for different periods (0, 2, 4, 8 and 12 weeks) at room temperature. Meanwhile, the biological part was carried out to study the biochemical changes occurred by feeding rats on diets containing fresh and stored oils either irradiated or unirradiated, as a sole source of fats. The biological evaluation of irradiated oils was studied by the determination of the effect of these diets on some parameters such as growth rate, food intake, and food efficiency of the animals.

The results revealed that there were a marked changes induced by either irradiation treatments or storage periods on the chemical properties and biological changes of the experimental anirals which were studied, especially by using high doses and prolonged storage periods.

Key Words: Irradiation, Gamma rays, lipids, fat, oil corn oil, olive oil, Nutrition.

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CONTENTS

INTRODUCTION

Fats and oils belong to the group of naturally occurring materials called lipids. The main source of fats and oils in the diet are milk products (cream and butter), animal fats (lard and beef tallow) and liquid edible oils i.e. (cotton seed oil, sunflower seed oil, corn oil, olive oil .... etc).

Fats and oils, like proteins and carbohydrates, are necessary as life sustaining ingredients of the human diet. The function of fats and oils in the diet is to serve as a source of energy.

Edible fats and oils are known to be sensitive to ionizing radiation. Irradiation of lipids results in a large number of compounds, the exact number depend upon the fatty acids composition. The main reactions involve oxidation, polymerization, decarboxylation and dehydration, which depend on the irradiation conditions, the structure of irradiated material, and the exposure dose level.

It is known that when fat is subjected to γ-irradiation distinctive off odour will be produced. The odour intensity and the rancidity of fat vary according to conditions during and time after irradiation.

Food irradiation processing proved to be able to inactivate pathogens, distracting infective parasitic stages, extending shelf life and keeping the natural freshness of many food commodities. In order to activate such objectives, an optimal radiation dose level should be applied which would not underline any side effects including rise in temperature, induction of radioactivity, alteration of organoleptic properties, depreciation of nutritive value, changes in chemical constituents or production of any toxic compounds.

The results evaluated by three international organizations; WHO/FAO/IAEA (1980) confirmed no detectable toxic effects of various food commodities subjected to radiation dose levels up to 10 KGy. Nevertheless, the report invited further studies on the wholesomeness and assessment of the nutritional value of certain foods irradiated at higher doses as well as the effect of combination of irradiation with other processing methods.

In the present work, two different vegetable oils, olive and corn oils, which are among the main traditional edible oils used for human consumption in Egypt, have been chosen to study the effect of gamma radiation in view of the following points:

1. The chemical changes induced by radiation in olive oil and corn oil at two different dose levels; in presence or absence of air oxygen, were followed up during storage for different periods.

2. The biological evaluation of the irradiated oils was also studied during feeding experiments on laboratory animals using diets containing oils treated in different ways to study some biochemical aspects such as growth rate, food consumption and food efficiency.

REVIEW OF LITERATURE

I. The chemical properties and fatty acids composition of oils:

1. Olive oil:

a) Chemical properties:

The chemical properties of olive oil produced in different countries were determined by several investigators.

Chemical properties of Italian crude olive oil were determined by Romeo et al. (1960). Average acid value was 8.6 while, saponification and iodine values were 189.32 and 82.6 respectively.

Balazs (1969) reported that chemical characteristics of olive oil were as follows; acid value 32, saponification value 192, iodine value 86 and peroxide value 4.

Andrea et al. (1970) reported that acidity percentage and peroxide value of sicilian virgin olive oil were 0.6-2.5% and 5.1-15.0 respectively.

Data collected on Albanian olive oil analysis were as follows: acidity 0.99-4.9%, iodine value 83.14-88.0 and peroxide value 9.9-24.0 (Gega, 1971).

Colakoglu (1972) studied the characteristics of Turkish olive oil. He found that it had the following properties: iodine value 73.8-91.40; saponification value 183.44-196.66, and acid value 0.48-24.20.

Itoh et al. (1973) reported that saponification value and iodine value of French olive oil were 192.0 and 84.9 respectively.

De Azeite (1974) found that portuguese virgin olive oil was characterized by the following properties; iodine value 80.5, free fatty acids such as oleic acid 1.6% while peroxide value was 12.8.

Gutifinger et al. (1975) reported that Israeli olive oil was characterized as follows: free fatty acids (% as oleic) 2.7-4.2, peroxide value 22.5, and iodine value 83.4-83.5.

On the other hand, El-Qadi (1976) notice that the properties of Egyptian olive oil were as follows: acidity 4.29-3.22, iodine value 82·02-81.4, while Saponification value was 194.2-197.0.

Chemical properties of shemlali cold, hot pulp and pressed olive oils were studied by Khalil et al. (1983) who showed that acidity as oleic acid was 0.36, 5.98 and

0.92; iodine value was 80.30, 83.4 and 82.02; peroxide value was 3.68, 11.69 and 7.81, while saponification value was 192.7, 193.6 and 192.0 for all types respectively.

b) Fatty acids composition of olive oil:

The saturated fatty constituents of olive oil are principally palmitic acid, with a smaller quantity of stearic acid beside traces of myristic and arachidic acids. On the other hand, unsaturated fatty acids consist mainly of oleic acid with a smaller quantity of linoleic acid. Small quantities of hexadecenoic acid could also be found. Reported data on chemical constituents of olive oil showed wide variations in the proportion of total saturated acids, with a tendency to contain high proportion of unsaturated acids. It also contains high concentration of linoleic acid. The fatty acids constituents of olive oil indicated that linoleic acid portion is a mixture of octadecadienoic acids, of which linoleic acid is the principal component (Eckey and Lawerence, 1954).

Craig and Murty (1959) found that the fatty acids constituents of olive oil are: palmitic 13.5; palmitoleic 1.3; stearic 3.2; oleic 74.8; linoleic 6.5; and linolenic 0.8%.

Herb et al. (1960) stated that the fatty acids composition of olive oil was palmitate 11.3, stearate 2.5, total saturated 14.0, palmitoleate 1.1, oleate 77.8, total monoenoate 78.9, linoleate 6.4, and linolinate 1.1%.

The following table shows the difference in percentage of fatty acids forming glycerides of olive oil obtained from four different countries as stated by Rotini (1961) and El-Qadi (1976).

Fatty acid	Tunis	Italy	Palestine	Jorden
Palmitic	13.9-21.1	7-25	10.5	13.65
Palmitoleic	0.98-2.2	0-2	-	-
Stearic	1.3-2.52	2-3	3.3	1.50
Linoleic	9.5-16.7	4-12	8.6	6.77
Linolenic	0.21-1.22	Traces	-	0.11
Oleic	59-70.6	65-84	77.5	74.93

Khalil et al. (1983) determined the fatty acid composition of the cold and hot pulp, pressed and commercially produced Egyptian olive oil. The percentages of the different fatty acids were as follows: 19.4-25.09% saturated fatty acids (0.03-0.30% myristic; 15.53-20.90%