EFFECT OF MICROWAVE HEATING ON CHICKEN FAT AND PROTEIN

BY

Nadia Y. Attia
Biochem. Dept., Fac. of Agric., Moshtohor, Zagazig Univ.

ABSTRACT

Whole chicken (Hubbard variety) were microwave heated for 0, 14, 16 and 20 mins. at frequency of 2450 MHZ to study the changes in its fat and protein. Acid, peroxide and thiobarbituric acid (TBA) values, fatty acid composition, protein fractions, digestibility and the molecular weights of the separated polypeptides were studied.

Gradual increase occurred in both acid and peroxide values but, TBA showed slight increase due to microwave heating. Microwave heat treatment caused increment in palmitic acid ratios which was accompanied with reduction in linoleic and linolenic acids ratios. Also, microwave heating caused a considerable reduction in protein solubility while digestibility increased by increasing microwave heating time up to 16 mins, but after 20 mins digestibility declined. Sodium Dodecyl Sulphate-Poly-Acrylamide Gel-Electrophoresis (SDS-PAGE) pattern of the separated polypeptides showed the presence of twenty bands with molecular weights ranging from 110 to 25 KD. Gradual disappearance in the number of the separated subunits was observed due to protein denaturation.

INTRODUCTION

Microwave heating has been applied extensively to the processing food products during the last decade. It is more energy efficient (Merine and Rosenthal, 1984) and reduces cooking time as compared to conventional heating. Speed and time saved are usually the most attractive features of microwave heating. Microwave heating are used in the food industry in several applications such as thawing, drying and baking (Rosenberg and Bogl, 1987) also for other applications such as pasteurization and sterilization of many types of foods (Ayoub et al., 1974).

Deep fat frying is one of the most commonly procedures used for the preparation of chicken and foods in which oil is continously heated at high temperature in the presence of moisture and atmospheric oxygen. As a result of these conditions, oxidation, polymerization, and degradation of the

oil occur (Perkins, 1967). These reactions lead to changes in the nutritional quality of the fried foods and perhaps effects on consumer health. On the other hand, microwave cooking showed great loss of several amino acids than conventional heat treatment (Chung et al., 1981). Also, Abd El-Aleem (1992) found that prolonging microwave heating time showed more destruction of both essential and non-essential amino acids of soybean seeds Clark variety. Yoshida et al., (1990) found that after 8-10 mins. microwave heating, the amount of tocopherols decreased substantially in linseed, olive and palm oils. Farag and Soad Taha (1991) found that butter conversion to samn by using microwave heating was accomplished in about one half of the time required for conventional heating. Microwave heating increased the development of samn oxidation rancidity compared with the conventional heating. Farag et al., (1992) reported that the peroxide values of the microwave beef liver lipids were nearly twice as high as that produced by conventional heating. Also oxidative degradation of fatty acids to short chain acids was noticed.

There is little information concerning the effect of microwave heating on the nutritional quality of foods therefore, the aim of this investigation was to study the effect of variable times of microwave heating on chicken fat and protein.

MATERIALS AND METHODS

Chicken (Hubbard variety) were purchased from the local market and the whole clean birds were used in this investigation.

Microwave heating: The fresh whole chicken were subjected to microwave heat treatment for 0, 14, 16 and 20 mins. A Moulinex microwave oven (Serie FMI) generating 0.5 KW power at 2450 MHZ was used in this study. After heating, the chicken were allowed to cool at room temperature before lipid extraction.

Analytical Methods: Chicken fats of different treatments were separated using Folch et al., method (1957). Acide and peroxide values were estimated according to the A.O.A.C. (1980). Thiobarbituric acid was determined according to Karl et al., (1949).

Fatty acids content: The fatty acids were determined as methyl esters according to Anon (1966) using Pye-Unicum series 304 gas chromatography with flame ionization detector under the following conditions: PAGA 10 % (polyethylene glycol adipate), Gas carrier nitrogen 30 ml/min. Inject temp. 250 °C, chart speed 1 cm/2 min., Detector temp. 160°C, column temp 300 °C. Standard fatty acids methyl esters were used as standard authentic samples. The amount of each individual fatty acid was determined according to Nelson et al.(1969).

Proteins extraction: a) The biuret method of Gornall et al., (1949) was used for water, salt and alkali protein estimation in crude extracts. A Pye-Unicum sp6-550 uv/vis spectrophotometer was used against a blank. The protein concentration was calculated by reference of a calibration curve of standard solution of bovine serium albumin. b) Proteins of the microwaved defatted chicken meat were extracted with 0.02 N sodium hydroxide (1:10 w/v) for determining the molecular weights of the polypeptide chains.

Gel Electrophoresis: Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) was performed to determine the molecular weight of the polypeptide chains according to Laemmli (1970), as modified by Studier (1973) on vertical slabs using POOMA-PHOR apparatus 2mm, (Laber-Mutter D-3310 Hann) as described by Stegmann et al., (1983).

Digestibility: was carried out in vitro according to the method described by Ford and Salter (1966) using the following equation:

$$\text{Digestibility} = \frac{\text{mg nitrogen in supernatent}}{\text{total nitrogen in the sample}} \times 100$$

RESULTS AND DISCUSSION

Fats extracted after chicken microwave heating at different periods (0, 14, 16 and 20 mins) were subjected to determine their acid, peroxide and thiobarbituric acid (TBA) values and the obtained results are shown in Table (1). Microwave heat treatments showed a slight increase in the free fatty acids. The liberation of the free acids from their triglycerides could be due to fat oxidation instead of hydrolysis (Farag and Soad Taha, 1991). Peroxide values for microwave heated samples increased rapidly by increasing

heating time. It is noteworthy that microwave heat cause high vibration to the molecules and in particular the labiie hydrogen atoms of the active methylene group adjacent to the unsaturated centers. These atoms become excited and the ensuring friction cause a considerable and rapid build up of heat which facilitates the abstraction of the hydrogen atoms. As a result, the produced free radicals rapidly react with the atmospheric oxygen and produce hydroperoxides. The mechanism for the hydroperoxides formed by microwave heating is similar to the reaction sequence of lipid autoxidation described by Allen and Hamilton (1983). Results concerning acid and peroxide values are in agreement with that obtained by Farag et al., (1992). Also, Table (1) shows the effect of microwave heating on thiobarbituric acid (TBA) values of the extracted chicken fat. The TBA values were slightly affected because they were determined after heating immediatly and without storing. Therefore the first oxidation reaction for microwaved heated samples occurred i.e. the formation of hydroperoxides but, did'nt prolonge the time to produce the secondary oxidation products (aldehydes and acids).

Fatty acids composition of different fat samples exposed to microwave heat treatment are shown in Table (2). It is noticed that oleic acid was the most abundant fatty acid (50.58 %), while palmitic and stearic acids were the prevailing among the saturated fatty acids. These results are in agreement with that of Igene et al., (1981). There were some increase of palmitic acid and decrease in both linoleic (1.08, 1.52 and 2.5 %) and linolenic acid (0.92, 4.23 and 5.08 %) after microwave heating for 14, 16 and 20 mins respectively. On the other hand, palmitic acid percentage increased 3.53, 7.74 and 9.82 % for the same heat periods (14, 16 and 20 mins). The concomitant increase in palmitic acid and the decrease of linoleic and linolenic acids contents can be interpreted to microwave energy. This energy was sufficient to cause double bonds migration in both unsaturated fatty acids to B-position followed by oxidative degradation at B-position and producing an acid lower by two carbon atoms than the parent acid. As a result, some of linoleic and linolenic fatty acids were converted to palmitic acid. Also, these results could explain the increase in the acid value due to microwave heat treatment. Similar results were reported by Shabana et al., (1992).

Table(1): Effect of microwave heat treatments on some chemical properties of chicken fat.

heating time(min)	Acid value	peroxide value	thiobarbituric acid value
zero (control)	0.62	3.71	0.13
14 min	0.69	5.14	0.14
16 min	0.74	10.54	0.18
20 min	1.60	12.71	0.20

Table(2):Effect of microwave heat treatment on chicken fatty acids composition

Fatty Acid %	Microwave heating time (min.)			
	0	14	16	20
Unknown	-	0.11	-	0.04
$C_{12:0}$	0.37	0.10	0.14	0.74
Unknown	-	0.18	0.13	-
$C_{14:0}$	0.49	0.44	0.22	0.23
$C_{16:0}$	20.67	21.40	22.27	22.70
$C_{16:1}$	11.56	11.52	11.40	11.38
$C_{18:0}$	2.95	2.90	2.88	2.85
$C_{18:1}$	50.58	50.03	49.81	49.31
$C_{18:2}$	12.99	12.87	12.44	12.33
Total sturated	24.48	25.13	25.64	26.43
Total unsaturated	75.13	74.42	73.65	73.25
sat/unsat	1:3.07	1:2.96	1:2.87	1:2.77

Protein fractions (Soluble proteins): Soluble proteins were measured colorimetrically and the obtained results are shown in Table (3). The major protein fraction of the unheated chicken defatted meat was the alkali fraction (Prolamins and glutelins (28.00 %). Microwave heat treatment caused a considerable reduction in protein solubility. The obtained results are in agreement with those obtained by Dowdie and Briede (1983).

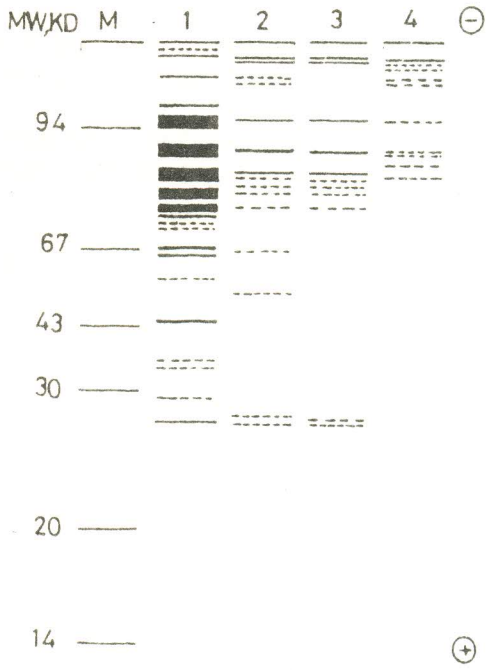
Protein Digestibility: The effect of microwave heating on protein digestibility of chicken meat in vitro is shown in Table (3). The digestibility increased by increasing microwave heating time up to 16 mins. (85.91 %) which was the suitable time for chicken cooking. These results could be due to the fact that heat treatment increase the digestibility due to protein denaturation which is parallel to protein destruction. After 20 mins. microwave heating digestibility declined, the reduction in digestibility could be probably due to Millard reaction and the formation of browning substances. Similar results were reported by Rhee and Rhee (1981), they found decrease in the digestibility of protein in vitro when browning substances were increased after microwave heating of legumes.

Electrophorctic patterns of chicken soluble proteins:

The alkaline soluble proteins of different microwave heating times were electrophoretically separated to its subunits in the presence of SDS and 2-mercapto ethanol (Fig, 1). Gradual disappearance in the number of the separated subunits was in parrallel with increasing the heating time. These findings have been confirmed by the detection of the number of subunits by SDS-PAGE. It is obvious that the bands intensity of the heated samples was very low compared with control. The unheated (control) polypeptide components of the alkaline soluble protein showed the presence of 20 subunits with molecular weights (MW'S) ranging from 25 to 110 KD. Five subunits were the major and have MW'S ranging from 100 to 74 KD, and seven subunits were of medium staining. Microwave heating caused reduction in the intensity of some bands and disappearance of others. Microwave heated sample for 14 min. showed the presence of 15 subunits with MW'S ranging from 25 to 110 KD with clear differences in band staining intensity. After 16 mins., which was the suitable time for cooking chicken, there were 11 subunits while after 20 mins. the color of the chicken was brown and showed the presence of 10 subunits only.

Table(3): Effect of microwave heating on protein fractions and protein digestibility.

Microwave heating time (min)	Protein Fractions %			Digestibility %
	Albumins	Globulins	Prolamins+ Glutelins	
0(control)	8.20	10.60	28.00	83.51
14	8.00	10.00	26.60	85.22
16	6.00	9.00	25.00	85.91
20	2.05	8.40	22.00	84.00



Fig(1): SDS-PAGE patterns of alkaline soluble proteins extracted after microwave heating

1- Control 2- 14 min. heating

3- 16 min heating 4- 20 min heating

Therefore microwave heating caused protein destruction effect on protein subunits specially those of high intensity, and the time of microwave heating was the main factor affected protein subunits.

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تاثير الميكروويف على دهن وبروتينات الدجاج

نادية يحيى عطيه

قسم الكيمياء الحيوية – كلية الزراعة – مشتهر – جامعة الزقازيق فرع بنها

تم تسخين الدجاج فى فرن الميكروويف لمده (صفر ، ١٤ ، ١٦ ، ٢٠ دقيقه لدراسه تاثير فترة التسخين على ارقام العامض والبيروكسيد والبثوباربيتوريك ومعتوى الدهن من الاحماض الدهنيه . كذلك تم دراسة تاثير الميكروويف على ذوبان البروتينات وهضم البروتينات وفصل السلاسل البيتديه باستخدام الاكتروفوريسيس (SDS-PAGE) .

أوضحت النتائج أن هناك زيادة فى رقمى العامض والبيروكسيد لكن الزياده فى رقم البثوباربيتبوريك كانت معدوده . ادى التسخين بالميكروويف الى زيادة نسبه حمض البالمتيك والتى كانت مصحوبة بنقص فى نسبه الاحماض الغير مشبعة مثل اللينولينك واللينولينيك .

أظهرت النتائج أيضا ان هناك نقص واضح فى نسبه ذوبان البروتينات بينما زاد معامل الهضم بزياده فتره التسخين حتى ١٦ دقيقه ثم انخفض ثانيا بعد ٢٠ دقيقه . وقد أظهر التفريد الكهربائى للبروتين المستخلص بعد التسخين بواسطه الميكروويف أن هناك اختفاء لعدد من السلاسل البيتيديه .