Evaluation of two cooking methods and precooking treatments on characteristics of chicken breast and leg

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RESUMEN

Evaluación de dos métodos de cocinado y tratamiento de precocinado sobre las características de pechuga y muslo de pollo.

Pechuga y muslo de pollo fueron tratados con soluciones de NaCl (4%) o STPP (3%) antes de ser cocinados en hornos convencionales o microonda. Mayor contenido en proteína, y menor contenido en grasa y oxidación lipídica (TBA) fueron encontrados en pechuga que en muslo. El tanto por ciento de humedad y los lípidos totales disminuyeron debido al proceso de cocinado. Las partes de pollo cocinadas en microonda tuvieron menos humedad e índice de TBA, mientras que las proteínas, lípidos totales, dureza de la piel y pérdida de cocinado fueron mayores que las producidas por cocinado convencional. Los asados cocinados en microonda fueron menos tiernos y ligeros en color, pero el aroma y flavor fueron mejor que los cocinados en horno convencional. El tratamiento en STPP antes del cocinado retuvo más humedad, proteína y grasa en las partes de pollo en comparación con las muestras tratadas con NaCl o no tratadas. Por otra parte, disminuyó la pérdida de cocinado, oxidación lipídica, índice de dureza de la piel y mejoró lo tierno y el flavor.

PALABRAS-CLAVE: Cocinado - Evaluación nutricional - Método (comparación) - Pollo - Precocinado (tratamiento).

SUMMARY

Evaluation of two cooking methods and precooking treatments on characteristics of chicken breast and leg.

Breast and leg of chicken were soaked in NaCl (4%) or STPP (3%) solutions before cooking in convention or microwave ovens. More protein, lower fat and lipid oxidation (TBA) were found in breast than in leg. Moisture percent and total lipids decreased due to cooking process. Chicken parts cooked in microwave had less moisture and TBA values, while protein, total lipids, shear force and cooking loss were more than that cooked conventionally. Microwave cooked roasts were less tender and lighter in colour, but aroma and flavour liked better by cooking in convention oven. Soaking in STPP before cooking retained more moisture protein and fat in chicken parts as compared with NaCl or untreated samples. Moreover, it decreased cooking loss, lipid oxidation, shear value and improved tenderness and flavour.

KEY-WORDS: Chicken - Cooking - Method (comparison) - Nutritional evaluation - Precooking (treatment).

1. INTRODUCTION

Chicken meat has a number of desirable nutritional and organoleptic properties, as well as low economic value per unit when compared to red meat. Precook marination of chicken is generally used by the fast food and convenience food industries to produce product with high consumer acceptability ratings.

The use of the microwave oven for heating meat represents a modern method of meat cookery that is extremely rapid and decreases energy costs, but it has not been well accepted by food services and homemaker for roasts due to uneven cooking, greater cooking losses and less palatable meat than conventional oven (Hutton *et al.,* 1981). Comparing microwave and conventionally cooked meat has indicated differences in sensory, physical and chemical characteristics of the muscle tissue (Dunn and Heath, 1979, Voris and Van-Duyne, 1979, and Hutton *et al.,* 1981).

Rancidity is detectable in some products heated by microwave but the degree of lipid deterioration is less than that caused by conventional heating method (Pikul *et al.,* 1984, King and Bosch, 1990).

Sodium chloride (NaCl) which added to several meat products for its functional properties was shown to promote lipid oxidation (King and Bosch, 1990). Sodium tripolyphosphate (STPP) widely used for reducing moisture losses during cooking, improved tenderness and flavour of cooked meat (Froning and Sackett, 1985, Young *et al.*, 1987, Paterson and Parrish, 1988).

Therefore, this study was conducted to compare microwave and conventional ovens for cooking chicken meat treated with NaCl and STPP, with respect to some chemical, physical and sensory attributes.

2. MATERIALS AND METHODS

Preparation of samples

A total of 28 male Fayoumy Breed Chicken were obtained from the flack of the experimental station, Faculty of Agriculture, Cairo University. They were slaughtered at 11 weeks of age using the subscald (59°-62°C) method of feather removal. Carcasses were cut up into front and hind quarters (breast and leg parts), then kept in refrigerator for two hours until ready for treatments. Randomly, two breasts and two legs were used for chemical determinations in raw samples.

Soaking treatments

One-third of either breast and leg chicken parts was soaked in sodium chloride (NaCl) at 4%, other third was soaked in sodium tripolyphosphate (STPP) at 3% and the later third was left without treatment (control). Soaking was carried out in jars containing solution for one hour at 25°C.

Cooking methods

Samples of each treatment of either breast or leg parts were randomly divided into two plots, each containing 9 parts representing 3 replicates. One plot of each treatment was cooked in conventional gas oven at 177°C for 105 min. Other plot was cooked in microwave oven "Moulinex Electronic Type 823" for 8 min for each side of breast and 6 min for each side of leg.

Proximate analysis

Total moisture percent, nitrogen and ether extractable fats were determined in raw fresh samples and after cooking (in both conventional or microwave ovens) according to the procedures described in AOAC (1984).

TBA assay

Lipid oxidation in chicken parts was determined by reaction with thiobarbituric acid regent (Ohkawa *et al*, 1979) and TBA number were expressed in terms of milligrams of malonaldehyde per Kilogram meat.

Cooking loss

Percentage cook loss was determined by taking the weight loss after cooking and dividing it by the original raw weight after soaking treatments.

Shear values evaluation

Shear values were measured using the Warner and Bratzler apparatus (capacity 50 x 0.ILB). Two 2.5 cm cores were obtained from the cooked breast or leg meat using a portable drill corer, and shear values were made on each sample at room temperature.

Sensory evaluation

Fifteen graduate students were used to evaluate chicken parts for tenderness, flavour, and exterior colour. The samples were scored on a 10-point hedonic scale so that the panelists may rate the degree of acceptability.

Statistical analysis

The Duncan's multiple range test Steel and Torrie, 1980) was used to determine differences between the means.

3. RESULTS AND DISCUSSION

Proximate analysis

The means of moisture percent in chicken parts (breast and leg) decreased due to cooking process (Table I). In general, percent moisture in the microwave cooked chicken parts was less than that cooked by the conventional method. This trend has been reported previously for poultry (Proctor and Cunningham, 1983). In contrast Voris and Van-Duyne (1979) did not show significant differences in the moisture content of round beef roasts due to cooking by microwave and conventional method.

It appeared also that NaCl and STPP treatments retained more moisture content in treated samples during cooking than not treated ones.

STPP was more effective than NaCl in this respect. Similarly Young *et al.,* (1987) found that NaCl and STPP increased moisture retention in poultry products, but there was an optimum level of these additives beyond which maximum moisture retention was not achieved. This probably due to the improving of meat binding properties with NaCl and STPP as detected by Young *et al.,* (1987), Paterson and Parrish (1988).

Breast and leg meat that cooked by microwave retained more protein percent than that cooked conventionally (Table I). The effect of cooking method on protein percent may be due to higher losses in water soluble protein and more formation of free amino acids by conventional than microwave cooking. This finding agrees quite well with other reports on poultry (Proctor and Conningham (1983). Otherwise, the increase of protein percentage may due to the decrease in water content.

Salt (NaCl) and sodium tripolyphosphate (STPP) treatments increased losses of total protein in chicken parts as compared with no treated samples. Higher loss was resulted by NaCl than by STPP regardless of the cooking methods, or chicken muscles. Similarly, Froning and Sackett (1985) recorded that NaCl rather than STPP increased the solubility of the myofibrillar proteins.

Total lipid level of breast muscle was low in contrast to red muscles (Table I). A result is in agreement with the finding of Pikul *et al.,* (1984) with chicken meat Cooking methods , microwave and convention, apparently did not alter the trend of total lipids in breast and leg parts of chickens. Microwave cooking resulted in chicken meat with slightly higher lipid content than that cooked in convention oven. Similar findings were obtained by Proctor and Cunningham (1983) with poultry meat.

As for the effect of soaking in NaCl or STPP, it appears that either of the treatments did not show appreciable effect on total lipids contents of chicken parts. These results coincide with that found by Babji *et al.,* (1982) with turkey breast muscle.

TBA Assay

Lipid oxidation causes deterioration of meat quality, especially during heating and subsequent storage (Melton,

Table I

Average chemical analysis TBA, cooking losses and shear values of treated and untreated poultry breast and leg after cooking by two different methods.

CHICKEN SAMPLES	**Chemical composition on wet weight basis**			**TBA mg malonaldehyde/ Kg meat**	**Cooking loss%**	**Shear values**
	Moisture %	**Protein %**	**Fat %**			
				Cooking in conventional oven		
Breast soaked in						
4% NaCl	65.35^{de}	24.65^{e}	4.56^{efg}	2.614^{b}	26.21^{d}	6.50^{def}
3% STPP	65.85^{cd}	24.88^{e}	5.04^{de}	0.764^{f}	25.46^{d}	7.70^{bc}
Control	63.78^{gh}	26.42^{b}	4.37^{g}	1.826^{cd}	37.60^{b}	8.20^{b}
Leg soaked in						
4% NaCl	67.32^{ab}	18.05^{j}	8.54^{bc}	2.967^{a}	30.95^{c}	5.9^{ef}
3%STPP	67.85^{a}	18.50^{i}	8.81^{ab}	0.840^{f}	26.26^{d}	5.50^{f}
Control	63.93^{fg}	21.68^{g}	8.35^{bc}	2.060^{c}	38.20^{b}	6.7^{cde}
				Cooking in microwave oven		
Breast soaked in						
4% NaCl	64.47^{fg}	25.19^{d}	4.96^{def}	1.667^{d}	26.47^{d}	7.60^{bcd}
3% STPP	64.77^{ef}	25.64^{c}	5.40^{d}	0.507^{g}	25.71^{d}	8.60^{ab}
Control	62.05^{h}	27.99^{a}	8.35^{f}	0.805^{f}	38.70^{a}	9.37^{a}
Leg soaked in						
4% NaCl	66.50^{bc}	19.41^{h}	8.76^{abc}	2.559^{b}	31.53^{c}	6.60^{cdef}
3% STPP	67.00^{b}	19.55^{h}	9.05^{a}	0.688^{fg}	26.53^{d}	6.05^{ef}
Control	63.12^{h}	22.16^{f}	8.61^{abc}	1.399^{e}	39.50^{a}	7.97^{b}
*Raw samples						
Breast	76.34	12.39	6.01	0.822	–	–
Leg	75.30	8.82	11.22	1.597	–	–

Means in the same column with different letters are significantly different at the 0.5 level.
*Not included in statistical analysis.

1983). The TBA assay measures the release of malonaldehyde, a secondary oxidation product of polyunsaturated fatty acids (Pearson *et al.,* 1983), and is said to be highly correlated with warmed-over flavour in muscle foods.

In general, the TBA values of chicken leg meat was higher than that of breast meat (Table I). This finding is in agreement with that found by Pitkul *et al.,* (1984) on lipid oxidation in chicken meat, since leg meat muscle had much more total lipids and two-fold more fat than breast meat. They added that phospholipid fraction contributed approximately 90% of the malonaldehyde measured in fat of chicken meat.

Lipid oxidation of microwave cooked samples appeared to be less than that of the conventionally heated samples. Similar results were obtained by Pikul *et al.,* (1984), King and Bosch (1990) on chicken and turkey meat. It could be attributed to inhibition of oxidation by Millard reaction products produced during heating by microwave (Angelo and Bailey, 1987).

Soaking of chicken meat in NaCl before cooking accelerated oxidative rancidity as compared with untreated control samples. Similarly, King and Earl (1988) King and Bosch (1990) also showed that NaCl promoted lipid oxidation in poultry and turkey meats. The effect of NaCl was suggested to be due to metal impurities especially iron or copper (King and Bosch, 1990). On the other side, sodium tripolyphosphate treatment resulted in lower TBA values than either control or NaCl treatment. Paterson and Parrish (1988) on beef roosts further found the prooxidant effect of salt have been marked by the antioxidant properly of the phosphates.

Cooking loss

Results shown in Table I reveal the influence of cooking method and soaking solutions on total cooking losses of chicken parts. Without the soaking treatments (control) the data indicated a tendency for cooking loss to be greater with microwave than with conventional cooking. This finding is in agreement with that found by Pikul *et al.,* (1984) in chicken meat. Voris and Van Duyne (1979) also recorded a significantly higher mean drip loss with microwave cooking than did conventional roasting. Hall and Lin (1981) added that broiler chickens cooked in the microwave oven had visible evidence of dehydration around the edges.

The difference in losses between the two cooking methods was much less for breast than for leg (2.9% and 3.4% for untreated breast and leg parts respectively). Such difference may be due to high losses of volatile fraction and drip from leg than from breast as previously recorded by Culotta and Chen (1973). High fat content in leg than in breast parts as indicated in table I could ascertain this explanation.

Soaking of chicken part (breast and leg) in NaCl or STPP solution before cooking reduced pronouncedly percentage of cooking losses during cooking either in convention or microwave oven when compared with untreated parts. Regardless of the cooking method sodium tripolyphosphate treatment was more effective in decreasing cooking losses than sodium chloride. In addition, leg muscles responded further to STPP treatment than breast muscles. Similarly, Froning and Sackett (1985), Young *et al.* (1987) and Paterson and Parrish (1988) revealed that both NaCl and STPP reduced cooking losses in turkey, chicken and beef meats respectively, through improving their binding properties. Babji *et al.,* (1982) explained the binding effect of salt by increasing the solubility of the myofibrillar proteins.

Shear values

Mean Warner-Bratzler shear values indicated that microwave cooked breast and leg muscles required greater amount of force to shear the samples than that cooked in conventional oven (Table I). Similar finding was obtained by Voris and Van-Duyne (1979) with top round roasts, which may be due to higher mean drip loss with microwave than conventional cooking. Otherwise, Roberts and Lawrie (1974) suggested that use of microwave oven does not allow time for collagen solubilization and tenderization.

Leg muscles required less force to compress than breast muscles. Also, treatment of both chicken muscles with NaCl or STPP before cooking resulted in less shear values as compared with untreated samples. This finding may be due to the increased moisture content in samples had low shear values (Table I). Similar, Paterson and Parrish (1988) indicated that the improving effect of NaCl and STPP on shear force to be due to their effect on increasing water binding properties of meat samples.

Sensory evaluation

Average score values of sensory attributes aroma tenderness, flavour, and exterior colour are shown in table II . In general the objective tenderness evaluation by taste panel agrees with the subjective shear press values of the same samples. This is true for both microwave and conventionally cooked breast and leg chicken meat received different treatments under investigation. This finding goes in parallel with the results of Dunn and Heath (1979) on poultry meat. It appeared also that dark meat received the best scores for tenderness in comparison to white meat, that agree with that findings by of Culotta and Chen (1973) on chicken. Microwave cooked chicken parts were less tender, but not significant, than that cooked in a conventional oven. Similar findings were obtained by Dunn and Heath (1979) on poultry. This may be due to degradation of the collagenous connective tissue and/or increased proteolytic enzyme activity that induced change in myofibrillar proteins with slow heat in convention oven than fast heat in microwave oven as cited by Hutton *et al.,* (1981). Sodium tripolyphosphate has been found to improve tenderness and followed by sodium chloride as compared with control. This result is in agreement with the finding of Froning and Sackett (1985), Young *et al.,* (1987), Paterson and Parrish (1988) as STPP especially when combined with NaCl improved tenderness of turkey, chicken and beef meats respectively. Aroma and flavour of the samples cooked by conventional oven was predicted to be liked better than that cooked by microwave. Similar results were obtained by Voris and Van Duyne (1979) on beef meat while Dunn and Heath (1979) did not show significant differences in flavour may be attributed to the differences in aroma of volatile components with the longer cooking time by conventional heating than microwave method (MacLeod and Coppock, 1976). Soaking of breast and leg muscles in sodium chloride of sodium tripolyphosphate improved the flavour as compared with control. Similar findings were obtained by Froning and Sackett (1985) with turkey breast muscle color of microwave cooked roasts was significantly lighter than the conventional roasts. The lower flavour scores of microwave roasts may be related to this lack of browning, since browning reactions are important in the development of flavour as well as colour (Voris and Van Duyne, 1979).

Table II
Sensory evaluation scores of treated and untreated poultry breast and leg after cooking by two different methods

CHICKEN SAMPLES	Palatability factors Aroma	Tenderness	Flavour	Exterior colour
	After cooking in conventional oven			
Breast soaked in				
4% NaCl	7.4^{ab}	7.8^{cd}	7.4^{ab}	7.3^{a}
3% STPP	7.5^{a}	8.2^{abc}	7.8^{a}	7.4^{a}
Control	7.1^{abc}	7.1^{e}	6.8^{cde}	7.2^{a}
Leg soaked in				
4% NaCl	7.5^{a}	8.2^{abc}	6.8^{cde}	7.2^{a}
3%STPP	7.4^{ab}	8.7^{a}	6.9^{cd}	7.3^{a}
Control	7.0^{bcd}	7.8^{cd}	6.4^{defg}	7.1^{a}
	After cooking in microwave oven			
Breast soaked in				
4% NaCl	7.0^{bcd}	7.6^{cde}	6.7^{def}	6.1^{b}
3% STPP	7.1^{abc}	7.9^{bcd}	7.2^{bc}	6.0^{b}
Control	6.9^{cd}	7.3^{e}	6.2^{fg}	6.1^{b}
Leg soaked in				
4% NaCl	6.7^{cd}	8.0^{bcd}	6.2^{fg}	6.0^{b}
3% STPP	6.8^{cd}	8.5^{ab}	6.5^{defg}	6.1^{b}
Control	6.6^{d}	7.4^{de}	6.0^{g}	6.2^{b}

Means in the same column with different letters are significantly different at the 0.5 level.

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